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WATER SUPPLY AND QUALITY CONTROL STUDY. TWIN SPRINGS PROJECT: BOISE RIVER BASIN

Federal Water Pollution Control Administration
Portland, Oregon

August 1966

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WATER SUPPLY & QUALITY CONTROL STUDY

TWIN SPRINGS PROJECT

AUGUST 1966

UNITED STATES DEPARTMENT OF THE INTERIOR
Federal Water Pollution Control Administration

NATIONAL TECHNICAL
INFORMATION SERVICE

WATER SUPPLY AND WATER QUALITY CONTROL STUDY

TWIN SPRINGS PROJECT

BOISE RIVER BASIN, IDAHO

An investigation defining present and potential water needs for municipal and industrial (M&I) supply and stream flow needs for maintenance of water quality in Boise River Basin has been made. A need for additional source development for M&I supply and for storage for regulation of stream flow for water quality control is revealed. Future water requirements and quality projections are based on economic, demographic, and engineering studies.

Prepared at the Request of the

District Engineer, U. S. Army Engineer District
Walla Walla, Corps of Engineers, Walla Walla, Washington

By the

U. S. DEPARTMENT OF THE INTERIOR
Federal Water Pollution Control Administration
Northwest Region, Portland, Oregon

August 1966

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1. INTRODUCTION

A. REQUEST AND AUTHORITY

The request for this investigation was made by the Walla Walla District, U. S. Army Corps of Engineers, Walla Walla, Washington, by letter dated August 5, 1963. The request was for an evaluation of municipal and industrial (M&I) water supply needs and stream flow requirements for water quality control and for an estimate of benefits that might be derived through releases from storage for these purposes.

Authority for the investigation is (1) the Memorandum of Agreement, dated November 4, 1958, between the Departments of the Army and Health, Education, and Welfare, relative to the Water Supply Act of 1958, as amended (43 U.S.C. 390b); and (2) the Federal Water Pollution Control Act, as amended (33 U.S.C. 466 et seq.).

B. PURPOSE AND SCOPE

The investigation was undertaken by the Federal Water Pollution Control Administration, Northwest Region, to evaluate the potential need for and value of storage for M&I water supply and for water quality control relative to the proposed Twin Springs Dam and Reservoir Project, located on the Middle Fork of the Boise River upstream from Boise, Idaho. To accomplish this, all available data on water uses, waste sources, and water quality were examined, evaluated, and projected. Water quality surveys were conducted as needed to define present conditions in the Boise River and tributaries.

The area covered in the report includes all of the Boise River Basin drainage and is defined demographically by areas within Ada, Canyon and Elmore Counties.

Evaluations include projected conditions for the design years of 1980, 2000 and 2020. An economic base study was prepared for this purpose and is summarized in the report.

This report considers the effects of the Bureau of Reclamation's proposed Southwest Idaho Water Development Project, Mountain Home Division - Guffey, Long Tom and Hillcrest Units on storage needs and values. The findings of the report are based on comprehensive studies being conducted in this region by the Federal Water Pollution Control Administration.

C. ACKNOWLEDGMENTS

This study was aided materially by officials of the Cities of Boise, Caldwell, Nampa, and Mountain Home; the Counties of Ada, Canyon and Elmore; the Boise Water Corporation; the Idaho State Department of Health; the Idaho Fish and Game Department; the U. S. Fish and Wildlife Service; the U. S. Bureau of Reclamation; the U. S. Geological Survey; the U. S. Army Corps of Engineers; and the engineering firm of Cornell, Howland, Hayes and Merryfield. The cooperation of these agencies is gratefully acknowledged.

II. SUMMARY of Findings and Conclusions

A. SUMMARY OF FINDINGS

1. The Twin Springs Dam and Reservoir Project, as proposed by the Corps of Engineers, would be located on the Middle Fork of Boise River about 47 miles east of Boise and 24 miles upstream from existing Arrowrock Dam. The reservoir would have a total capacity of 600,000 acre-feet at elevation 3,850, with 490,000 acre-feet of usable capacity for flood control, power production, water quality control, and conservation. Management of the reservoir would be coordinated with existing water resource development in the Boise River Basin.

2. The study area covered in the report is the entire Boise River drainage basin, including the area south to the Snake River, as defined demographically by Ada, Canyon, and Elmore Counties in Southwest Idaho. Major subareas examined in the study are those with centers at Boise, Caldwell, Nampa, and Mountain Home.

3. The Boise River Basin drainage area is over 4,000 square miles. The basin's existing reservoirs are Anderson Ranch, Arrowrock, and Lucky Peak. About 1,000,000 acre-feet of usable storage capacity has been developed in these reservoirs mainly for irrigation. In addition to operations for irrigation, the entire system is operated on a forecast basis for flood control and for recreation on Lucky Peak Reservoir where during most seasons, levels favorable to this use are maintained.

4. Water law in the State of Idaho provides priorities on beneficial diversionary uses of water. On a shortage basis the priorities from highest to lowest are: domestic supply, mining, agriculture, milling and power. Stream flow regulation for water quality control is not recognized in the law of the State.

5. The average annual recorded flow of the Boise River at the lowermost gaging station (drainage area 3,820 square miles) is 1,190 cubic feet per second (cfs) or about 860,000 acre-feet. The one-in-ten year low mean annual flows of the Boise River at several points from upper to lower basin adjusted for present regulation are:

	cfs	Annual Acre-Feet
Boise Diversion Dam.....	1,500	1,085,000
Near Boise.....	700	560,000
Near Notus.....	325	735,000

Minimum flows in the main stem of the river have occurred below Lucky Peak Dam (<1 cfs) during fall maintenance shutdowns for as long as three months and below Caldwell (<50 cfs) during spring, summer, and early fall months when diversions are being made for irrigation.

6. The economic base of Boise Valley is agriculture, with more than 370,000 acres irrigated and nearly 1,560,000 acre-feet of water diverted annually from Boise River for this purpose. With the Bureau of Reclamation's proposed Mountain Home Division added to the system, an additional annual diversion of 174,000 acre-feet would be made during good water years. Complete regulation of the river above Boise would occur on a frequency of about one out of two years.

7. The study area's 1960 population was 170,000. About 70 percent of this population resided in urban areas and 30 percent resided in unincorporated towns and rural areas. There is potential for considerable population growth. The projected populations for 1980, 2000 and 2020 are 245,000, 365,000 and 562,000, respectively.

8. The study area's municipal water use is about 19.6 million gallons per day (mgd), and seasonal industrial use spread on an average annual basis is about 13.4 mgd. Essentially all water for these purposes is obtained from underground sources. Based on projected population and industrial growth for the area, the potential demand for water for these purposes by the years 1980, 2000 and 2020 is 55, 95 and 150 mgd, respectively. The demand for industrial water supply has been increasing at a significantly greater rate than the municipal demand in recent years.

9. The quality of groundwater for municipal water supply is generally within recommended limits, although the City of Boise has recently been experiencing some rather serious, and apparently increasing water quality problems. Excessive concentrations of fluoride, iron and manganese have, at times, caused severe nuisance conditions in Boise.

10. The City of Boise has expressed an interest in obtaining Boise River water from storage in the Twin Springs Project as an alternative or supplemental source of water supply. The City has undertaken a study of its water supply in order to evaluate the magnitude of its problems and future needs.

11. Surface waters, in addition to being used for irrigation, are used for fish and game propagation, stock watering, recreation, and

assimilation of municipal and industrial (M&I) wastes. Stream waters in the lower basin below Boise receive and at times consist almost entirely of return flows and drainage water from irrigated lands.

12. The mineral and organic quality of surface waters in Upper Boise Basin areas is excellent. Waters in the lower reaches of the main stem below Boise are significantly higher in mineral and organic content (Appendix B, Pages B-4 and B-5), and have been observed to contain excessive turbidity, sediment, biological slimes, and numbers of bacterial organisms (Appendix B, Page B-6). Survey data show that the critical dissolved oxygen (DO) zone occurs below Caldwell (near Notus) and is most pronounced under predawn conditions during summer and early fall months (FIGURE 7).

13. The Idaho State Department of Health has recently achieved considerable success in obtaining improved water quality through improvements in M&I waste treatment practices along Boise River. The goal of this agency is to achieve at least 85 percent removal of the biochemical oxygen demand (BOD) produced by major municipalities and industries in the area.

14. Average municipal waste production in the study area at present is about 105,000 population equivalents (PE). It is estimated that after treatment about 25,000 PE of this waste is discharged to Boise River and tributaries.

15. Industrial waste production varies considerably by season with maximum-concurrent production totalling about 695,000 PE (September), and minimum production totalling about 195,000 PE. During maximum-production periods, about 146,000 PE of treated industrial waste is disposed to Boise River and tributaries.

16. From studies of similar conditions in another basin, it is estimated that wastes from agricultural sources add about 3 milligrams per liter (mg/l) of BOD to waters of the Boise River during summer and fall months. Also, data show that considerable increases in nutrients and minerals (Appendix B, Pages B-4 and B-5) occur in conjunction with flows returned to the river from irrigation and land drainage.

17. Increased water temperatures have been observed in Boise River where flow depletions for irrigation occur. Between Caldwell and Parma, for example, stream temperatures attain levels in the order of 70 to 75 degrees Fahrenheit whereas during the same period temperatures upstream in the vicinity of Twin Springs are in the order of 60 to 65 degrees Fahrenheit.

B. CONCLUSIONS

1. The future economic growth of Boise Valley will be dependent, to a large extent, on the continuation and intensification of water resource development for agriculture and allied purposes. The Corps of Engineers' proposed Twin Springs Project, with its provisions for irrigation and power, and the Bureau of Reclamation's proposed Southwest Idaho Water Development Project, Mountain Home Division - Guffey, Long Tom, and Hillcrest Units, are examples of efforts being made to further this development.

2. Municipal and industrial water needs in the study area are expected to increase from about 33 mgd at the present time to about 150 mgd by the year 2020. Groundwater, in view of the area's recharge characteristics, is expected to be available in sufficient quantity and quality to meet the projected demand in all areas with the exception of the Boise area.

3. Expansion of groundwater pumping facilities to satisfy expanding municipal and industrial requirements in the Boise area has resulted in deterioration of water quality. This expansion in the future may be expected to result in further quality degradation and possibly result in quantity problems.

4. The most likely source of alternative or supplemental water supply to meet the future needs of the City of Boise appears to be surface water from the Boise River.

5. Municipal and industrial water supply for the City of Boise should be considered as a project function of the Twin Springs Project. The actual amount of storage required to serve this purpose cannot be determined at this time, but will become available if and when the City of Boise undertakes a detailed engineering study of its future water supply requirements.

6. Depletions in stream flow by storage during winter months and diversion for irrigation during summer months, coupled with waste discharges from M&I sources and wastes in runoff from agricultural sources, have resulted in the curtailment of game fish production, and a reduction in recreational opportunities and aesthetic values in and along about 50 miles of the lower Boise River. Recent improvements in M&I waste treatment have reduced to some extent the pollutional effects of these wastes on the river.

7. Additional irrigation development, increased population, and industrial growth along the Boise River are expected to cause a further reduction in water quality, particularly below the Boise and Caldwell areas. For example, oxygen-demanding waste, even after a reasonable level of treatment is applied, is expected to exert greater demands on the DO resource of the river below these areas. Stream temperatures

(already relatively high, 70-75° F), algal growths, turbidity, and other indicators of water quality in this reach will also increase as economic expansion progresses.

8. The future control of water quality in the Boise River will require provisions for (1) adequate waste treatment or other control of waste at the source; (2) continuous disinfection of municipal waste treatment plant effluents, including industrial sanitary wastes; (3) assured quantities of stream flow to maintain a minimum DO level of at least 6 mg/l in the Boise reach and 4 mg/l in the Caldwell-Notus reach; (4) controlled surface and sub-surface drainage to reduce turbidity, nutrients, and temperature; and (5) controlled use of pesticides to eliminate possibilities of these materials entering stream waters. If these controls are not accomplished, the possibility of upgrading or preserving recreational opportunities, aesthetic and public health values, and assets associated with an attractive stream will be progressively reduced.

9. Continuous expansion of M&I waste treatment facilities will be needed to keep pace with population and industrial growth in Boise River Basin. Loadings to Boise River and tributaries by the year 2020, even with adequate waste treatment (85 percent BOD removal), are expected to more than double present loadings or to increase to about 300,000 PE during periods of maximum waste production.

10. Judging from field observations and the results of computer studies incorporating oxygen-balance techniques, it has been shown that treated waste loads projected for 1980, 2000 and 2020 upon being received in the one-in-ten year design flow will depress the DO resource of Boise River below the recommended limits of 6 mg/l and 4 mg/l in the Boise and Caldwell reaches, respectively.

11. By the year 2020, an average annual stream flow of 150 cfs (varying monthly from approximately 90-305 cfs) at Boise and 235 cfs (varying monthly from approximately 180-305 cfs) at Caldwell will be required to maintain adequate water quality for fish life, recreation, and maintenance of aesthetic values in and along Boise River. In order to maintain these flows in 90 percent of the years there is a need for an annual draft-on-storage of 98,000 acre-feet from Twin Springs Reservoir for downstream release at Lucky Peak Dam. Regulation will be needed beginning at the time of assumed project completion (about 1975). Releases would be required at such times and in such amounts as may be dictated by seasonal variations in waste loadings and DO conditions downstream, and would not be a substitute for adequate waste treatment (at least 85 percent BOD removal).

12. Summer releases at Lucky Peak Dam, in excess of those for irrigation diversion downstream, are expected (by adding depth over the streambed below diversion points) to exert some improvement in stream temperatures, in addition to maintaining DO objectives.

13. Controlled storage releases from Twin Springs Reservoir for maintenance of water quality below Lucky Peak Dam would benefit a potential population of 550,000 persons residing along more than 50 miles of the river and would improve fishing and other recreational uses. For example, according to the Fish and Wildlife Service's Twin Springs Report, the fishing effort is estimated at about 9,000 angler-days per year at the present time and would be expected to increase considerably with favorable water quality conditions.

14. The benefits derived from flow regulation for water quality control in the Boise River Basin are both tangible and intangible and would accrue after a reasonable degree of waste treatment has been provided at all major waste sources. The riparian owners, downstream water users, and surrounding area's population would be the recipients of the benefits of this control. As these beneficiaries are widespread throughout Boise River Basin, the cost to provide quality control regulation in Twin Springs Reservoir would be non-reimbursable.

15. The value of the benefit assignable to Twin Springs Reservoir for water quality control in Boise River, after adequate waste treatment is applied, is considered to be at least equal to the cost of achieving the additional required control by use of the most likely alternative means available in the absence of the project. Among the alternatives examined, flow regulation was found to be the only method of achieving similar results. The cost of providing this flow regulation on a single-purpose basis is considered to be a reasonable measure of the value of the widespread benefit. The Twin Springs site was selected for this determination.

16. The minimum value of the benefit assignable to an annual draft-on-storage of 98,000 acre-feet in Twin Springs Project for water quality control, based on capital and investment costs to develop single-purpose storage at the Twin Springs site, is estimated to be $686,000 or $7.00 per acre-foot. This value represents an approximation of the annual equivalent Federal expenditure involved in maintaining water quality in Boise River over a 100-year project life at 3.125 percent interest, including operation and maintenance expenses.

17. In order for water quality control benefits to be fully realized, a means must be devised whereby flows may be allowed to pass downstream during maintenance shutdown at Lucky Peak Dam.

18. After the project is in operation a system of water quality and waste monitoring and stream flow forecasting will be needed in order to fully utilize flow regulation for water quality control.

III. PROJECT DESCRIPTION

A. LOCATION

The proposed Twin Springs Dam and Reservoir site is located on the Middle Fork of the Boise River about 47 miles east of Boise, Idaho, and 24 miles upstream from the existing Arrowrock Dam. The general location of the project in relation to other significant features of the study area is shown on the Location Map (inside back cover). The drainage area above the damsite consists of 830 square miles of forested lands, which contribute an average annual water runoff of 847,000 acre-feet. The area's average annual rainfall is 34 inches.

B. PROPOSED PROJECT

The Twin Springs Project would be multiple-purpose in scope, providing a total of 600,000 acre-feet of storage, with 490,000 acre-feet of active capacity. The project would be operated in coordination with the existing Anderson Ranch, Arrowrock, and Lucky Peak Reservoirs to maximize utilization of Boise River waters. Primary benefits attributable to the Twin Springs Project would accrue from power production at the site and at the proposed Lucky Peak powerplant. In addition, the project would provide greater potential for regulation of the entire river system for flood control and for increase of minimum stream flows at critical points. Increased flows would serve to maintain and restore fishery resources and provide adequate capacity for assimilation of treated M&I wastes. Water impounded in this site area would be of suitable quality for these purposes.

IV. STUDY AREA DESCRIPTION

A. LOCATION AND BOUNDARIES

Because of the extensive use or development ot the region, the area selected for study includes the Boise River Basin drainage area plus the area between the Boise and Snake Rivers. This study area conforms closely to Ada, Canyon, and Elmore Counties in Southwestern Idaho and is a part of the Central Snake River Basin. The Boise River enters the Snake River at River Mile 391.3, near which point the Snake River becomes an interstate stream forming the boundaries of the States of Oregon and Idaho (see Location Map, inside back cover).

The economic base study area, the demographic study units, and the water supply service area, which are formed by the boundaries of Canyon, Ada and Elmore Counties, generally conform to the water resource drainage area and the water quality evaluation area mentioned above.

B. PHYSICAL FEATURES

The Boise River originates in the Sawtooth Mountains, flowing west to join the Snake River. The headwaters area is mountainous and includes many peaks higher than 10,000 feet in elevation. About 8 miles upstream from Boise, the river emerges from the mountains and meanders for about 60 miles through a large, flat alluvial valley bordered by the benchlands of the Snake River Plain. The region between the Boise and Snake Rivers is a relatively level area which, in general, slopes gradually downward to the northwest from an elevation of about 3,300 feet near Mountain Home The uniformity of the general area is broken by a distinctive drainage pattern, a few volcanic cones and craters, and some higher plateaus and buttes.

C. CLIMATE

In fifty years of climatological record, the average annual precipitation in the study area was approximately 10 inches. Much of the precipitation occurs in the form of snow during the winter, and the remainder occurs as scattered thunderstorms. During most of the summer, the area is dry and hot with maximum temperatures in the vicinity of 110 degrees Fahrenheit (^{o}F). The temperatures during the winter months are also relatively extreme, with minimum temperatures of record below minus 35^{o} F.

The growing season for pastures, alfalfa and similar hardy crops usually extends from April through October. This represents an interval in excess of 200 days favorable for hardy crop growth. The frost-free season extends for a period of about 145 to 170 days. Soil types vary considerably, but much of the area consists of loam, silt, or clay-loam.

D. PRINCIPAL COMMUNITIES

The City of Boise is located in Ada County adjacent to the Boise River. The Cities of Nampa and Caldwell are located in Canyon County and together represent a major urban-industrial complex adjacent to the Boise River downstream some 35 miles from Boise. Mountain Home, the principal city of Elmore County, is located outside the Boise River Basin on the plateau between the Boise and Snake Rivers.

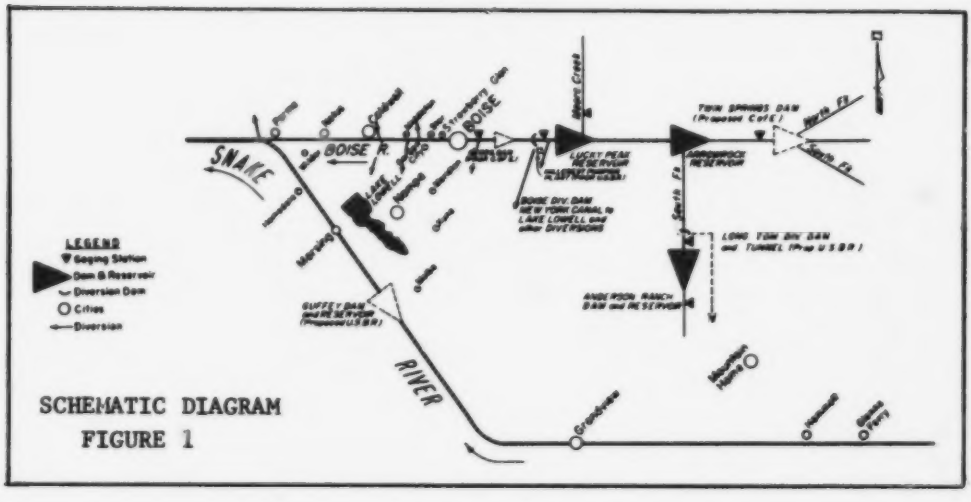
V. WATER RESOURCES of the Study Area

A. SURFACE WATER

1. Existing Water Resource Development

FIGURE 1, Schematic Diagram, shows the major reservoirs, streams, diversions, and cities of the basin. To a large extent, water resource development in the Boise River Basin and associated area is oriented toward irrigated agriculture. At present, three major reservoirs provide storage for irrigation in the Boise Valley. These reservoirs have a combined active capacity of nearly 1,000,000 acre-feet, divided among the reservoirs as follows:

Reservoir	Active Capacity (acre-feet)
Anderson Ranch	423,200
Arrowrock	286,000
Lucky Peak	278,000



SCHEMATIC DIAGRAM
FIGURE 1

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About 50,000 acre-feet of storage space in Lucky Peak Reservoir has been set aside for fishery use downstream. As this space is keyed to carry-over storage from the previous irrigation year there are times when little, if any, of this water is available for downstream release.

The proposed Twin Springs Project would add 490,000 acre-feet of active storage capacity in the Boise River Basin. In addition, the Bureau of Reclamation's proposed Mountain Home Division - Guffey, Long Tom and Hillcrest Units development would alter the present water management scheme to make more complete use of the Boise River for irrigation. The proposed project would include diversion of stored water from Anderson Ranch Reservoir through Long Tom Tunnel to the Mountain Home Plateau and utilization of Snake River water as new, replacement, or supplemental supply for some 125,000 acres of land.

Because irrigation use overshadows every other use of the basin's waters, water resource management practices have developed in line with the desires and needs of the irrigators. With the addition of the proposed projects, water resource development will be approaching maximum. As an illustration of the extent of present development in the Boise River Basin, the average annual runoff at Boise River Diversion Dam was computed by the Bureau to be 1,890,000 acre-feet; the average annual requirements for irrigation at the same point are 1,560,000 acre-feet, which leaves an average of about 330,000 acre-feet per year (450 cfs) for all other uses downstream from Boise Diversion Dam (excluding return flows and small streams). With the proposed Mountain Home Diversion added to the system complete regulation of the river above Boise would occur on a frequency of about one out of two years.

Boise Valley water rights are defined by the "Stewart" and "Bryan" decrees, and by licenses and certificates of water rights issued by the Idaho Department of Reclamation. The rights are administered by a watermaster in accordance with priority of right and amount of water available. In some years, the quantity of water available falls below the requirements of the right holders, and competition among multiple uses becomes keen. Water supply records document short periods with little or no flow at Boise and with less than 100 cfs at Notus. Idaho water law does not recognize stream flow or its regulation for water quality control as a legitimate function of water resource management.

The operation of Lucky Peak Dam and Reservoir, with respect to annual "shutdowns" for maintenance at this installation, is of particular importance. The effect and duration of these "shutdowns" are shown in TABLE V-1. Low flows below the dam are occasioned by the fact that there is no provision in the structure for passage of flows during these maintenance operations. The Idaho State Game Commission, U. S. Fish and Wildlife Service, and Federal Water Pollution Control Administration are on record as opposing this practice as low flows have been detrimental to the maintenance of fish populations of the stream and have resulted in critical conditions for M&I waste assimilation in the Boise Area.

TABLE V-1
NUMBER OF LOW-FLOW DAYS AT
LUCKY PEAK RESERVOIR OUTLET WORKS
(USGS Gaging Station No. 13-2020)

Year	Flow ≤1 cfs	≤Flow 50 cfs
1955	142	145
1956	93	94
1957	116	116
1958	12	14
1959	88	104
1960	7	116
1961	134	158
1962	107	129
1963	9	79
1964[a/]	10	13

[a/] During 1964, 92 days ≤55 cfs.

2. Stream Flow Frequency Analysis

The proposed Twin Springs Dam and Reservoir (USACE project) and the proposed Mountain Home Division (USBR project), when added to the Boise River system, would effect essentially complete regulation of the river. The manner in which these waters are regulated is of particular importance in dealing with organic waste disposal. Variations in the rate and velocity of stream flow, and the duration and frequency of flow by time and place determine to what extent DO will be depressed by organic wastes and to what level regulation may be needed to protect stream uses.

FIGURE 2 shows the probable magnitude and frequency of average annual stream flows at several points in the Boise River system. FIGURE 3 depicts an approximation of the annual distribution of stream flows at several locations of particular importance to the water quality evaluations described herein.

As established later in the report, water quality maintained at or above minimum objectives on a nine out of ten year frequency would provide adequate protection of stream uses. For design purposes, therefore, water quality determinations and flow regulation requirements for Boise River were based on stream flows expected on a one-in-ten year low-flow recurrence basis.

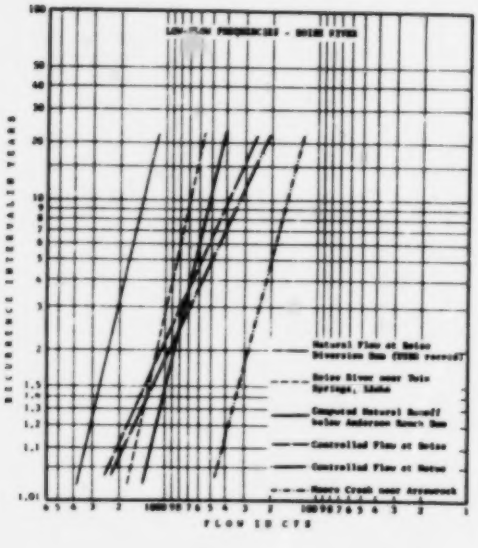

FIGURE 2
LOW-FLOW FREQUENCIES

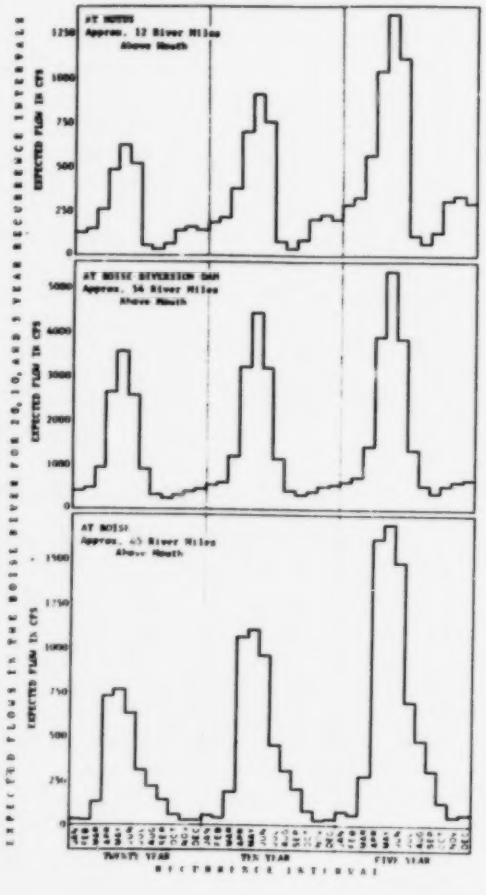

FIGURE 3
LOW FLOW HYDROGRAPH

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FIGURE 4 illustrates the distribution of flows available in two critical water quality reaches of the Boise River. The design hydrograph for the Boise reach was constructed from records at the gaging station above Boise. This hydrograph approximates the distribution of flows to be expected with the diversion by the proposed Mountain Home Division. The design hydrograph (FIGURE 4) for the Caldwell reach was constructed from records at the Notus gaging station. Records at the Notus gage reflect irrigation return flows entering the river below Caldwell and do not, therefore, represent actual flows available in the river between Notus and Caldwell after diversions are made. The design hydrograph for the Caldwell reach was, therefore, adjusted to account for this difference.

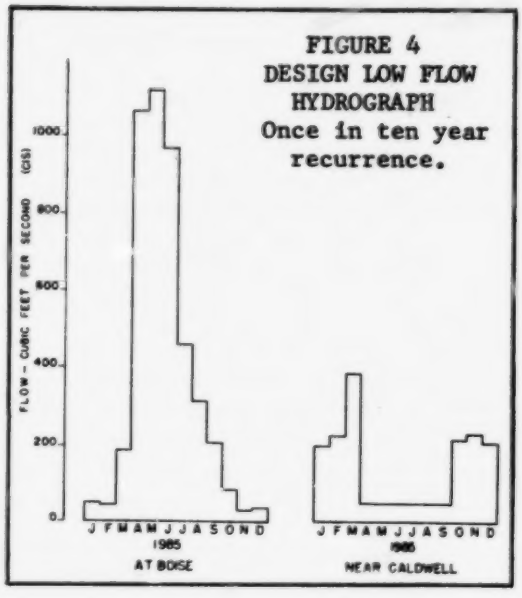


FIGURE 4
DESIGN LOW FLOW HYDROGRAPH
Once in ten year recurrence.

3. Quality of Water Available

Boise River water quality is degraded as it flows downstream. TABLE V-2 and APPENDIX B (Tables 1-4) show typical examples of water quality at several locations along the river. The phosphate (>0.01 mg/1) and nitrate (>0.3 mg/1) concentrations shown in TABLE V-2 for lower reaches are in excess of threshhold limits for stimulation of aquatic organisms. The over-all mineral quality, however, is adequate for M&I uses. FIGURE 5 typifies the total solids in the Boise River, and indicates a general trend of increasing solids concentrations as the river proceeds downstream (APPENDIX B, Table 4).

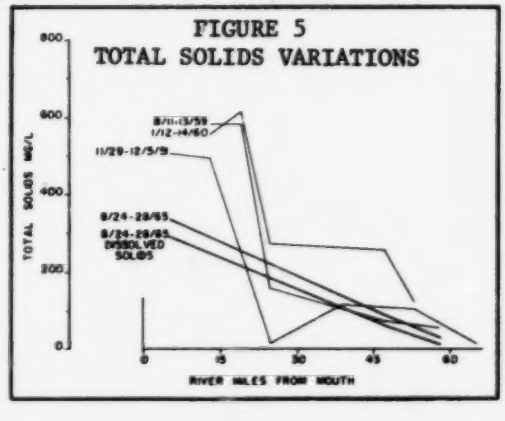


FIGURE 5
TOTAL SOLIDS VARIATIONS

TABLE V-2
WATER QUALITY DATA
BOISE RIVER BASIN, IDAHO

Constituents	Twin Springs	Near Arrowrock	At Boise	At Notus
Date	10/1/58 to 9/30/59	4/1/39 to 1/17/40	4/28/59	10/1/51 to 9/30/52
Number of Samples	26	29	1	39
Sampling Frequency	Daily	Daily	High Flow	Daily
Discharge, cfs	1,074	2,580	1,610	2,525
Silica (SiO_2), ppm	12	--	14	20
Fluoride (F), ppm	0.57	--	0.57	0.38
Calcium (Ca), ppm	8.2	12.40	12.0	18.0
Magnesium (Mg), ppm	0.37	1.58	0.37	4.98
Sodium (Na), ppm	2.95	--	4.60	18.86
Potassium (K), ppm	0.39	--	0.78	1.95
Sulfate (SO_4), ppm	2.40	4.32	3.36	22.08
Chloride (Cl), ppm	0.35	0.71	0.35	5.68
Nitrate (NO_3), ppm	0.00	0.62	0.62	2.48
Bicarbonate (HCO_3), ppm	32.94	54.29	48.19	89.67
Dissolved Solids[1/], ppm	46	72	65	142
Hardness, as $CaCO_3$, ppm--				
Calcium Magnesium	22	38	32	65
Non-Carbonate	0	0	0	0
Specific Conductance Micromhos @ 25° C	60	98	89	206

[1/] Residue on evaporation at 180° C.

SOURCE: U. S. Geological Survey Professional Paper 417-D, 1964 (Table 1, Page D-36 & 37).

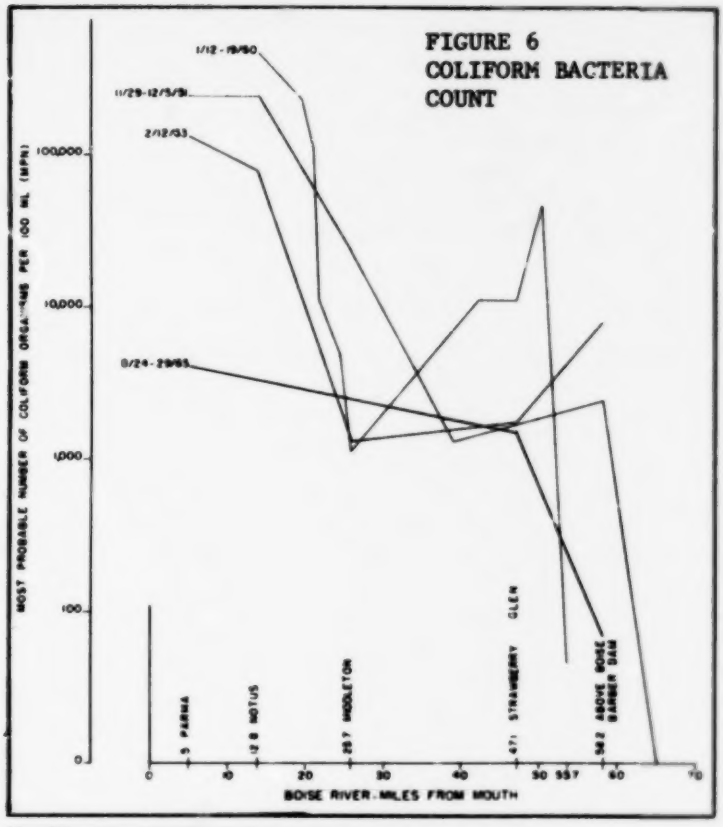


FIGURE 6
COLIFORM BACTERIA COUNT

Examples of the bacterial quality of Boise River are given in FIGURE 6. All four surveys plotted indicate a trend of increasing bacterial counts from upstream to downstream. The results of these surveys are shown in APPENDIX B (Tables 1-4). The bacterial quality below Boise is unsatisfactory for swimming (>1,000 coliforms per 100 ml) or as a raw water supply (>5,000 coliforms per 100 ml) for treatment by conventional methods for municipal and food processing purposes.

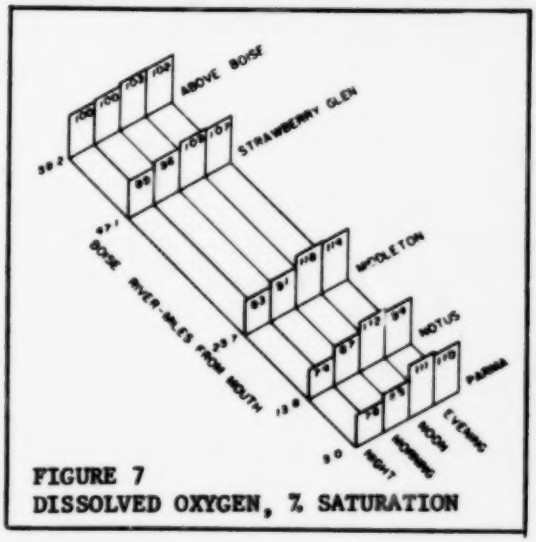


FIGURE 7
DISSOLVED OXYGEN, % SATURATION

The dissolved oxygen (DO) pattern in Boise River, as shown in FIGURE 7, exhibits considerable diurnal fluctuation and was lowest during the August 1965 survey in the vicinity of Parma (5.3 mg/l). Photosynthetic and respirational activities of aquatic organisms are believed responsible for the diurnal DO fluctuation in Boise River. DO data from several sampling runs completed during August 1965 are shown in APPENDIX A (Tables 1-5).

Organic matter, as measured in terms of five-day biochemical oxygen demand (BOD_5) has varied from less than 1 mg/l in the upper reaches above Boise to an average of about 6 mg/l in the lower reaches.

Water temperature data presented in TABLE V-3 indicate Boise River temperatures above Arrowrock Reservoir reach freezing levels in the winter. Summer temperatures are moderate, reaching an average monthly maximum value of 63° F. Maximum temperatures of 72° F have occasionally been recorded.

TABLE V-3
AVERAGE MONTHLY TEMPERATURES
BOISE RIVER BASIN, IDAHO

Month	Boise River near Twin Springs 1955 - 1957	South Fork Boise River at Anderson Ranch Dam 1963	Boise River at Notus* 1950 - 1958
October	48	--	58
November	37	--	49
December	35	--	44
January	35	40	44
February	33	40	44
March	36	40	48
April	41	40	53
May	44	43	60
June	49	44	66
July	61	44	77
August	63	45	76
September	57	45	67

* Maximum values, temperature observations made @ 4:00 p.m.

Source: U. S. Geological Survey and U. S. Bureau of Reclamation.

The monthly average temperatures shown in TABLE V-3 for the Boise River at Notus are based on observations made at about 4:00 p.m. daily and represent, therefore, the average of daily maximum values. Winter temperatures are in the order of 45° F, while July and August values are in the high 70's. Average daily temperatures for July and August are probably on the order of 72 to 73° F.

B. GROUNDWATER

1. Quantity

Groundwater in Boise River Valley is an important complement to the surface water resources of the area. Essentially all of the municipalities in the basin utilize groundwater for supply purposes. In addition, groundwater is used extensively by self-supplied industries, rural residences, and irrigators.

Recharge estimates of the U. S. Geological Survey (USGS)[1/] indicate that an additional average annual yield of 324,000 acre-feet of groundwater is available in the Boise River Basin. Although this figure holds true for groundwaters in the basin as a whole, specific areas can show quite marked differences in both quantity and quality.

2. Quality

Chemical constituents of surface and ground waters were compared by the Geological Survey in Water Supply Paper No. 1376. TABLE V-4 is a summary of data extracted from that paper. These data indicate that surface waters are of better general chemical quality than groundwaters, but either is acceptable for domestic water supply, irrigation, and most industrial supply. Treatment may be necessary for specific purposes, but the water can be treated satisfactorily by conventional methods.

According to groundwater studies by the Idaho Agricultural Experiment Stations it is feasible to re-use much of the groundwater for irrigation purposes without an undue accumulation of salts. It was pointed out, however, that waters in some areas are subject to increased salinity which may require mixing with water of lower salinity to maintain a suitable quality level.

1/ Upper Snake River Basin - Wyoming, Idaho, Utah, Nevada, Oregon, Volume III, Part 2, Coordinating and Reports of Cooperating Agencies, U. S. Geological Survey, Ground Water Branch; U. S. Bureau of Reclamation, and U. S. Army Corps of Engineers, 1961.

TABLE V-4
SURFACE AND GROUND WATER CHEMICAL ANALYSES
BOISE RIVER BASIN, IDAHO

Constituent or property 1/	Surface water			Ground water		
	Number of Samples	Maximum	Minimum	Number of Samples	Maximum	Minimum
Silica, SiO_2	9	35	12	60	93	14
Iron, Fe	3	--	.00	49	1.4	0
Calcium, Ca	26	61	7.9	89	87	7.9
Magnesium, Mg	26	25	Trace	89	41	.3
Sodium, Na	16	93	3.7	50	250	7.5
Potassium, K	16	18	Trace	55	93	0
Sodium and potassium calculated as sodium	10	172	3	33	134	1
Bicarbonate, HCO_3	26	291	36	89	476	54
Sulfate, SO_4	26	244	2.7	88	309	.8
Chloride, Cl	26	93	.8	89	97	0
Fluoride, F	3	.6	.2	50	7.0	0.0
Nitrate, NO_3	13	5.9	.3	57	41	0
Boron, B	3	.04	.02	49	.36	.02
Dissolved solids	13	788	51	66	1,040	69
Hardness:						
Total	13	251	21	66	386	24
Noncarbonate	5	31	0	40	214	0
Percent sodium	26	60	14	88	82	5
Residual sodium carbonate-- milliequivalents per liter	26	.75	--	89	4.24	0
Specific conductance - micromhos at 25°C	26	1,160	67	66	1,510	112
pH	18	8.6	6.9	87	8.8	6.6
Temperature --- °F	5	75	59	73	80	52

1/ Chemical constituents in parts per million (ppm)

SOURCE: U. S. Geological Survey, Water Supply Paper No. 1376

VI. THE ECONOMY

A. GENERAL

The demand for water for municipal and industrial purposes, and the amount and character of waste waters resulting from such uses, are determined largely by the activities associated with a region's economic base. The purpose of this section is to present economic and demographic data to be used as a basis for projecting the needs for water for municipal and industrial purposes and for estimating the future amounts and types of waste and land drainage material that may be expected to occur in the Boise River Basin with the expanded development anticipated in the future.

The economic base study area and the demographic study units were assumed to conform to the boundaries of Ada, Canyon and Elmore Counties, Idaho.

B. PRESENT

1. Economic Activities

Agriculture dominates the economy of the Boise River Basin. Principal crops are meat animals and feed, and food grains and hay; but substantial outputs of potatoes, sugar beets, field seeds, vegetables, and dairy products are also produced under irrigation in the fertile soils of the Snake Basin. Irrigated acres total more than 370,000.

Services and trade are extremely important constituents of the economic base. The City of Boise provides a substantial portion of the service requirements of southern Idaho and eastern Oregon, as well as many administrative services for the State of Idaho. Defense installations at Mountain Home and substantial population concentrations about the Nampa-Caldwell food processing area have created secondary service foci in these communities.

Manufacturing displayed exceptional growth in the basin during the nineteen-fifties, with food processing providing much of the impetus. Most significant of the area's manufacturing plants are the Amalgamated Sugar refinery at Nampa, the J. R. Simplot cannery and freezing plant at Caldwell, and the Swift and Co. meat packing plant in Boise. A number of smaller meat and poultry packing plants and several dairy processing plants and small canneries are found in the basin. Other manufacturing activities include lumber and wood-processing mills at Boise and Mountain Home; trailer fabricating plants in Boise, Nampa, and Caldwell; and the miscellaneous machinery, metal fabricating, and masonry activities required to support the industrial and agricultural base.

Development of the area's economy since 1950 has been marked by increasing agricultural productivity, with attendant farm consolidation and falling agricultural employment. Rapidly growing food processing and miscellaneous manufacturing have absorbed the released farm labor and have expanded at a sufficient rate to create additional employment opportunities. The area shared fully in the national trend to higher concentration on provision of services. Construction activities contributed to the general expansion, with construction of highways and dams, emplacement of the Mountain Home defense complex, and expansion of the Morrison-Knudson construction firm that is headquartered in Boise. TABLE VI-1 lists employment distribution by industry in 1950 and 1960 and contrasts 1960 distribution with that of the United States to provide an indication of the nature of economic specialization and its recent development.

TABLE VI-1
INDUSTRY DISTRIBUTION OF EMPLOYMENT
BOISE RIVER BASIN, IDAHO
1950 and 1960

Industry	Employment (1,000's)		Percent of Labor Force		
			Boise Basin		U. S.
	1950	1960	1950	1960	1960
Basic Resources					
Agriculture	9.3	8.3	18.5	13.2	6.6
Forestry & Fisheries	0.1	0.2	0.2	0.3	0.1
Mining	0.2	0.1	0.4	0.1	1.0
Construction					
Construction	4.7	5.0	9.4	7.9	5.6
Manufacturing					
Food and Kindred	1.3	3.2	2.6	5.1	2.6
Other	1.3	3.0	2.6	4.8	22.9
Trade and Services					
Transp., Communications, Util.	4.7	5.0	9.4	7.9	6.6
Trade	10.4	13.3	20.7	21.1	18.0
Public Administration	2.8	3.9	5.6	6.2	4.9
Other Services	12.3	17.5	24.5	27.8	27.9
Unemployed	2.7	3.2	5.4	5.1	5.2
TOTAL, Labor Force	50.2	63.0	100.0	100.0	100.0

2. Population

Population growth in the region during the last two decades has occurred at a rate well in excess of that of the State of Idaho and of the Nation as a whole. Growth has been primarily due to rapid industrialization with emphasis on food processing in Ada and Canyon Counties, development of trade and service occupations in Boise (Idaho's capital and largest city), and emplacement of an Air Force base and missile base near the town of Mountain Home in Elmore County. TABLE VI-2 lists populations for 1940, 1950 and 1960, and contrasts the rate of population growth with that of Idaho and the United States.

With the exception of the expanded rural population in Elmore County, the population growth in the study area has been generally restricted to urban areas. The rural component of total population has declined from 44 percent in 1940 to about 30 percent in 1960.

TABLE VI-2
POPULATION DISTRIBUTION AND GROWTH, BOISE BASIN, IDAHO, 1940-60

AREA	POPULATION 1940	POPULATION 1950	POPULATION 1960	AVERAGE ANNUAL RATE OF GROWTH 1940-60	AVERAGE ANNUAL RATE OF GROWTH 1950-60
Ada County	50,401	70,649	93,460	3.1%	2.9%
Boise, City	(26,130)	(34,393)	(34,481)		
Associated Areas	(2,100 E)	(15,724 E)	(39,486)		
Boise Urbanized Area[a/]	28,230 E	50,117 E	73,967	6.6	4.0
Kuna	443	534	516	0.8	-0.8
Meridian	1,465	1,810	2,081	1.8	1.1
Rural	20,263 E	18,188 E	16,896	-0.9	-0.7
Canyon County	40,987	53,597	57,662	1.8	1.5
Caldwell	7,272	10,487	12,230	3.5	1.5
Middleton	477	496	541	0.6	0.9
Nampa	12,149	16,185	18,013	2.0	1.1
Notus	277	313	324	0.8	0.3
Parma	1,085	1,369	1,295	0.9	-0.6
Wilder	507	555	603	0.9	0.8
Rural	[illegible],220	24,192	24,656	1.2	0.2
Elmore County	5,518	6,687	16,719	5.7	9.5
Glenns Ferry	1,290	1,515	1,374	0.3	-1.0
Mountain Home	1,193	1,887	5,984	8.4	12.2
Rural	3,035	3,285	9,361	5.8	11.1
BOISE RIVER BASIN					
Total	96,906	130,933	167,831	2.7	2.5
IDAHO				1.1	1.2
UNITED STATES				1.6	1.7

a/ Estimates of the Boise Urban Area rest on examination of census tract maps and include only contiguous built-up areas. The Ada County Planning Commission includes 76,137 in its definition of the urban area for 1960, plus 5,040 persons as mixed, rural non-farm and farm population, and 1,388 in rural areas to obtain a population of 82,565 for its definition of the Boise Metropolitan Area.

C. FACTORS INFLUENCING FUTURE GROWTH

Agricultural production may be expected to continue to be the major force underlying the economy of the basin. The area is favored with fertile and adaptable soils; and climate and growing season lend themselves to agricultural production. With the exception of large parcels of land in Elmore County proposed for future development by the Bureau of Reclamation, the raw input of land is not expected to increase appreciably. Unquestionably, the addition of irrigation capabilities will have a greater bearing on increased production than any change in total acreage of land devoted to agricultural use. The pace of new irrigation must slow over the next fifty years due to limits in the availability of soil and water. Indeed, maturation of the potato-processing industry and the adjustment to the expansion of the market for beet sugar (created by disruption of established supply sources) indicate that the exceptional market growth that spurred development of irrigation after 1959 is not presently a factor in promoting new irrigation.

The employment opportunities offered by agriculture may be expected to continue to shrink. While the improvement of labor productivity in farming which marked the nineteen-fifties cannot be expected to continue, the techniques now available would permit a considerable reduction in the work force simply through continued consolidation of smaller farms. It is reasonable, however, to expect a lower than national rate of employment decline, in view of the large relative size of present farms and the prospect for substantial additions to irrigation. It is anticipated, then, that the area will continue to increase its proportion of total national employment in agriculture.

The food processing industry will continue to have an adequate source of raw materials, based on the prospects of increased agricultural output. The products of the industry will, in all probability, continue to be those now produced--meats, dairy goods, potatoes and sugar--with somewhat more intensively processed fruits and vegetables. These are materials which the region is well suited to produce and which enjoy favorable demand trends.

Meat packing holds the potential for vigorous future growth. Idaho production of meat animals is presently about two-and-one-half times its slaughter, in terms of weight. Production of meats, moreover, is only slightly higher than the local state consumption. Thus, the area is well able to slaughter and export finished meat products from its stock of presently exported live animals. This would be in keeping with the trend in force in the industry--packing near the point of production

rather than in consumption centers. Since the region exports not only cattle but the feed to fatten them, the conditions for cattle feeding, slaughter and meat packing are all favorable. Another regional factor to be taken into account is the fact that the western states have a marked, though slowly declining, deficiency in pork production relative to consumption. As efforts to increase hog production succeed, hog slaughter should grow to fill the production deficit.

Beet sugar production has advanced rapidly since the disruption of normal supply channels following suspension of the Cuban quota and the consequent lifting of domestic production quotas. Although per capita consumption of sugar has been fixed for several decades at 110 to 115 pounds per year, beet sugar has filled a growing portion of the total.

Processed potatoes, whose output and market acceptance skyrocketed during the last decade, should also show substantial increases in production. Increased efficiency in the industry, including the stretch-out of the production season, is expected. The projection of output for potato processors, then, is based on more efficient utilization of capacity rather than aggressive expansion. Thus, it is unlikely that total output will grow faster than population.

Processing of dairy products, like the dairy farming upon which it is built, has expanded vigorously in the region and should continue to rise, with fast-growing Pacific Coast States, particularly California, and improved transportation creating expanding markets for Idaho dairy farmers.

Other processed agricultural products, such as fruits, vegetables and prepared foods, should also display significant growth. The region's ability to provide a variety of raw materials should interact with the trend to greater processing of foods to create a sustained growth of output of these products.

The output of forest products in the region may be anticipated to expand. Although the declining trend of per capita use of lumber continues, other wood base products continue to display vigorous demand patterns that contribute to the need to utilize more intensively the inelastic supply of forests. It may be assumed with relative assurance that development of the area's timber supplies will become increasingly intensive. Coastal forests are, for the most part, being exploited at, or above, sustained yield levels. Although the total supply of western softwood timber should become greater due to the assertion of the more rapid growth of young, second-growth tree stands, continued population growth should result in expansion of demand that requires broadening use of the study area forest resource.

Miscellaneous manufacturing, i.e., all manufacturing other than food processing and production of lumber and other forest products, has grown at a rate in excess of other significant sources of employment opportunities in the area in recent years. Growth, however, has been closely related to that of primary industries, agriculture, food processing and lumbering. In effect, growth of output and activity in primary industries has created markets for the products of related industries. To the extent that growth of the primary industries has resulted in increased employment and population, broader markets have also been created for other products--consumers goods for the most part.

D. FUTURE

The forecast of future economic development, expressed in terms of the region's areas of specialization, is based on the probable continuation of agriculture as the primary regional industry; with added irrigation, including the substantial increment envisaged in these projects, and continuing improvements in technology contributing to increases in output.

Manufacturing growth may be expected to continue, with emphasis on food processing. Because the area is expected to become the source of a greater share of the total U. S. food supply, the physical output of such products as sugar, processed potatoes and preserved fruits and vegetables may be expected to rise at a greater rate than United States demand for these goods, or at a rate in excess of two percent per year. Since consumption of meat and dairy products is favored by rising living standards, as well as other factors affecting the region's food output, output increases approaching a three percent annual increase seem reasonable. Continuing expansion of the service ratio and high levels of construction activity, which are accepted parts of most forecasts regarding the national economy, both should support economic growth in the basin, which has maintained a relatively high level of such activities historically.

Population, following the course of employment opportunities, should continue to rise in the study area at a rate in excess of that of the State of Idaho. It is anticipated that the annual growth rate for the basin will approximate 1.9 percent from 1960 to 1980, 2.0 percent from 1980 to 2000, and 2.1 percent from 2000 to 2020. Population concentration in larger urban places may be expected to continue to occur, based on the growth of employment opportunities in manufacturing and services and the continuing decline of agricultural employment. For example, the projected annual rate of population increase for the Boise urbanized area during the study period (1960-2020) is 2.7 percent.

The estimated future population distribution and magnitude is shown in TABLE VI-3.

TABLE VI-3
ESTIMATED FUTURE POPULATION
BOISE RIVER BASIN, IDAHO

Location	Population (in thousands)		
	1980	2000	2020
Boise Urbanized Area	125.8	212.0	363.5
Nampa-Caldwell	45.8	69.5	105.3
Mountain Home Urbanized Area	15.8	22.2	31.6
Meridian	3.2	4.6	5.8
Glenns Ferry	1.8	2.4	3.3
Parma	1.7	2.3	3.2
Wilder	0.7	0.8	0.9
Middleton	0.7	1.1	1.6
Kuna	0.6	0.7	0.9
Notus	0.4	0.5	0.6
Ada County Rural	16.9	16.9	16.9
Canyon County Rural	24.7	24.7	24.7
Elmore County Rural	4.0	4.0	4.0
TOTAL	244.8	364.6	562.3

VII. WATER REQUIREMENTS
Municipal & Industrial

A. PRESENT WATER USE

Water use in the study area for municipal purposes is about 19.6 mgd (14,200 acre-feet per year) and for industrial purposes is about 13.4 mgd (9,700 acre-feet per year).

Essentially all water for these purposes is obtained from underground sources. The City of Boise and the surrounding suburban area are served by the Boise Water Corporation from more than twenty wells as well as by numerous smaller water corporations. Nampa is served by six wells, Caldwell by fourteen wells, and Mountain Home by four wells. Other municipalities use from one to three wells for supply. Most of the major industries in the basin obtain water from their own private well supplies.

Quality of municipal water supplies, as indicated by data shown in APPENDIX B (Tables 1-3) is generally within recommended maximum limits of the U. S. Public Health Service Drinking Water Standards. The City of Boise, however, has recently been experiencing some rather serious, and apparently increasing water quality problems. Some wells are producing water with excessive concentrations of fluoride, iron and manganese, and severe nuisance conditions in the form of taste, odor and color have occurred within several public water systems as a result of the high iron and/or manganese concentrations. In the opinion of the Idaho State Department of Health, the agency responsible for maintaining water quality surveillance of municipal water systems. the water quality problems of Boise are likely to continue increasing in the future as larger quantities of water are drawn from the groundwater aquifer.

B. FORECAST OF FUTURE NEEDS

Future municipal water demand in the study area is projected to be about 36.5 mgd, 65.9 mgd and 109.7 mgd by the years 1980, 2000, and 2020 respectively, as shown in TABLE VII-1. Per capita demands were estimated from present consumption data gathered from the various cities involved, from the Idaho State Department of Health, or from engineering firms working for the cities; 1960-1963 data were used for this purpose. It was assumed that per capita demand in the over-all study area would increase at a rate of about 0.4 percent per annum except in the Glenn's Ferry and Parma areas where in 1960 use rates were 500 and 385 gpcd, respectively. These rates, indicating losses, would not be expected to increase and most probably will be reduced.

TABLE VII-1
PRESENT & PROJECTED SERVED POPULATION AND MUNICIPAL WATER DEMAND
BOISE RIVER BASIN, IDAHO

Municipality	Population (in thousands)				1960 Design (gpcd)	Demand - mgd			
	1960	1980	2000	2020		1960	1980	2000	2020
Boise, Urban Area.....	74.00	122.50	218.00	350.00	185	13.70	24.40	46.80	80.40
Nampa-Caldwell.....	30.20	45.50	70.00	101.00	125	3.78	6.15	10.15	15.68
Mountain Home, Urban Area.....	12.00	15.60	22.20	31.20	200	2.40	3.37	5.15	7.74
Meridian.....	2.10	3.30	4.70	6.20	100	0.21	0.35	0.55	0.77
Glenns Ferry.....	1.40	1.80	2.40	3.20	500	0.70	0.95	1.39	2.00
Parma.....	1.30	1.70	2.30	3.10	385	0.50	0.69	1.03	1.49
Wilder.....	0.60	0.68	0.76	0.84	150	0.09	0.11	0.13	0.16
Middleton.....	0.50	0.70	1.10	1.60	100	0.05	0.08	0.12	0.19
Kuna.....	0.50	0.57	0.71	0.90	200	0.10	0.12	0.16	0.22
Eagle.....	0.50	0.57	0.75	1.10	100	0.05	0.06	0.09	0.13
Star.....	0.40	0.44	0.48	0.52	100	0.04	0.05	0.06	0.61
Gowen Field.....	0.40	0.54	0.81	1.20	150	0.06	0.09	0.14	0.22
Notus	0.30	0.38	0.46	0.54	125	0.04	0.05	0.07	0.08
Melba	0.20	0.20	0.25	0.36	50	0.01	0.01	0.01	0.02
TOTAL	124.40	194.48	324.92	501.76	2,470	19.57	36.49	65.85	109.71

The community of Mountain Home has indicated a desire to obtain water diverted from Anderson Ranch Dam. They have asked the Bureau of Reclamation for water to be distributed to them as shown in the adjacent tabulation:

Year from Completion of Guffey Project	Acre-feet per Year	cfs	mgd
1 - 10	1,000	1.38	0.9
11 - 20	2,000	2.76	1.8
21 - 30	3,000	4.15	2.7
31 - 35	4,000	5.54	3.6
36 - 50	5,000	6.90	4.5

The present capacity of the Mountain Home wells is about 2.2 mgd. Projected use is 3.37, 5.15, and 7.74 mgd by the years 1980, 2000, and 2020 respectively. On the assumption that the well supply will be abandoned in favor of a treated surface supply, the values shown are reasonable expectations and the City of Mountain Home could use project water as an alternate source.

The City of Boise has submitted a letter to the Federal Water Pollution Control Administration expressing an interest in the possibility of obtaining Boise River water from storage in the Twin Springs Project as an alternative or supplementary source of water supply. The letter expressed concern about the present water quality problems being experienced in Boise and the potential future problems associated with both water quality and quantity. It was indicated that the City of Boise is undertaking a study to evaluate future water supply requirements, to evaluate the adequacy of groundwater to meet these future requirements, and to determine the necessity of using surface water from the Boise River as an alternative or supplemental water supply source.

In view of Boise's increasing water quality problems, its rather large projected future water demands, and the unknowns associated with the adequacy of the present groundwater source of supply, municipal and industrial water supply should be considered as a project function in the Twin Springs Project. The actual amount of storage required to meet this need cannot be determined at this time, but will become available if and when the City of Boise undertakes a detailed engineering study of its future water supply requirements.

Consulting engineering studies of the Nampa and Caldwell water supplies have concluded that groundwater is available in sufficient quantity and quality to supply the needs in this area to about the year 2010.

Industrial water demands shown in TABLE VII-2 were projected by applying unit water-use data to projected production estimates described in Chapter VI. The significance of these figures is limited, however, by the fact that industrial demand in terms of average annual mgd gives an inaccurate picture; needs are seasonal and demands for supply occur during definite monthly periods and are not distributed evenly throughout the year. The water demand pattern coincides seasonally with industrial waste production shown in FIGURE 8, Chapter VIII. The potential industrial water demand by the years 1980, 2000, and 2020 is projected to be about 18.9 mgd (21,200 acre-feet per year), 27.3 mgd (30,600 acre-feet per year), and 38.0 mgd (42,500 acre-feet per year), respectively. TABLE VII-2 shows the present and expected future industrial water demand for the three major industrial areas with a breakdown of their industrial categories.

The industrial demand period (August-May) coincides favorably with periods of groundwater recharge from irrigation and seasonal precipitation. Groundwater, therefore, is expected to be available in sufficient quantity to meet the future industrial demand.

TABLE VII-2

PRESENT & PROJECTED INDUSTRIAL WATER DEMAND, BOISE BASIN, IDAHO

Location Industry	Ac-Ft per Year (1,000's)			
	1960	1980	2000	2020
BOISE				
Meat	0.26	0.57	0.84	0.93
Milk	3.69	5.70	8.15	11.92
Total	3.95	6.27	8.99	12.85
NAMPA				
Sugar	7.10	8.30	12.50	17.70
Potato	0.13	0.19	0.22	0.26
Meat	0.48	1.06	1.54	1.72
Canning and freezing	0.19	0.32	0.58	1.00
Total	7.90	9.87	14.84	20.68
CALDWELL				
Potato	1.67	2.51	2.88	3.34
Meat	0.35	0.77	1.12	1.25
Milk	0.71	1.09	1.56	2.29
Canning and freezing	0.41	0.68	1.22	2.09
Total	3.14	5.05	6.78	8.97
TOTAL Acre-feet (rounded)	15.0	21.2	30.6	42.5
AVERAGE mgd	13.4	18.9	27.3	38.0

VIII. WATER QUALITY CONTROL

A. NEED FOR CONTROL

1. General

The uses of surface water in Boise River Basin for which water quality is important are irrigation, fish and game propagation, stock watering, and recreation. Public health, the aesthetic environment, and land values are other important values associated with water quality.

2. Irrigation

The average annual water demand for irrigation in Boise River Basin is about 1,950,000 acre-feet. Of this, about 1,560,000 acre-feet (demand at Boise Diversion Dam) is live runoff water originating in the basin and 390,000 acre-feet, according to recent studies by USBR, is reused return flow. The proposed Mountain Home Division (USBR project) will create an additional demand of 174,000 acre-feet at Boise Diversion Dam increasing the total annual demand at that location to 1,734,000 acre-feet. The remainder of water supply to Mountain Home Division will come from the Snake River. According to the Bureau of Reclamation, these waters (including reused return flows) are of suitable mineral quality to irrigate the crops presently grown and anticipated to be grown in the area.

3. Fisheries

Anadromous fish runs have disappeared from the Boise River due to unfavorable quality conditions in the river and to the construction of Brownlee and Oxbow Dams on the Snake River.

Trout, kokanee, mountain whitefish, and yellow perch exist in the upper stream reaches and reservoirs. Limited natural reproduction of trout has led to a stocking program for most of the reaches above the town of Star. Carp and other trash fish are the only species that find favorable conditions below Caldwell.

A recent Fish and Wildlife Service report on the Twin Springs Dam Project indicated a projected average annual use of the Boise River from the diversion dam to the town of Star of 9,000 angler-days without Twin Springs Project and 24,750 angler-days with the project. A year-around fishery is permitted, but the major effort occurs during the winter non-irrigation season.

The five-year average liberation of trout into the lower Boise River and irrigation drains to the river is 41,100 rainbow trout. Releases of brown trout fry numbering 107,000 and 193,000 were made by the Idaho Fish and Game Commission in the last two years. Sizeable releases of rainbow trout not included in the above figures are made annually into Lucky Peak Reservoir.

4. Stock Watering

It is estimated that the gross demand for water for stock watering in the entire Snake River Basin is about 32 mgd. A large portion of this demand occurs in the Boise Valley. The trend in stock watering is towards concentrated watering at specific points. Boise River Valley is the center of the region's cattle-feeding, dairying and poultry industries. Large scale, intensified cattle feeding is an industry that has been growing at the same rapid rates as potato processing and sugar refining. This growth implies large point demands for water which, in turn, implies potentially significant sources of waste concentrations.

5. Recreation and Riverside Uses

The streams and reservoirs in Boise River Basin are within short driving distance of the major urban populations and attract weekend swimmers, boaters, fishermen, and campers. Activities at recreation sites on Arrowrock, Anderson Ranch, Lucky Peak, and Lake Lowell, for example, have averaged over 800,000 visitor-days annually in recent years. Because social trends indicate that people are working shorter hours and have more leisure time, a greater demand for water-oriented recreation is foreseen. Water of suitable quality to accommodate this demand is, therefore, essential.

6. Aesthetic Environment

The Boise River Valley has been historically, and continues to be, a part of the main east-west line of passage between the northern Pacific Coast and the regions of the Nation lying beyond the Rockies. Those who live in the area and those who pass through it are constantly in view of the river. The quality of the physical environment is being recognized locally and nationally as important in terms of community feeling, productivity, and individual satisfaction.

B. MUNICIPAL, INDUSTRIAL, AND AGRICULTURAL POLLUTION

1. Present

a. Municipal and Industrial (M&I)

Wastes produced in the Boise River Basin consist of domestic sewage, cannery wastes, potato and sugar beet processing wastes, slaughtering and meat packing wastes, milk products wastes, and such miscellaneous land wastes as those from stockyards, farm drainage, and irrigation return flows. M&I wastes before treatment vary from about 800,000 population equivalents (PE)[1/] during maximum-concurrent production periods to about 300,000 PE during minimum-production periods. Depending upon the season, industrial waste constitutes from 65 to 90 percent of the total waste generated in the area.

Treatment methods and disposal practices employed in the basin vary from septic tanks, with subsurface disposal in areas not served by collection systems, to secondary waste treatment systems, which provide 85 to 90 percent BOD removal. Industrial wastes, in some instances, are treated in combined municipal systems and, in other instances, by separate treatment facilities. Some industries and municipalities do not have treatment facilities at the present time. TABLE VIII-1 lists the sources and approximate strength of wastes produced and discharged to Boise River. The totals shown in TABLE VIII-1 represent maximum loadings that can occur concurrently.

On a basin-wide basis, existing treatment facilities are capable of achieving about 80 percent BOD removal during maximum loading periods. The Idaho State Department of Health in reporting on the pollution problems in the area (X-5 and X-6) has recommended that facilities be provided to reduce all waste loads by at least 85 percent, particularly during periods of maximum waste production. The goal of the Idaho program is to obtain greater industrial waste treatment efficiency in the Nampa and Caldwell areas where major loadings to the river occur.

b. Agricultural Pollution

The Bureau of Reclamation estimates that irrigation return flows amounting to over 350,000 acre-feet occur annually as a result of irrigation water applied to Boise Valley lands (X-3). Much of this flow returns to the Boise River and is rediverted for irrigation.

1/ PE = 0.167 pounds of five-day biochemical oxygen demand (BOD_5) per day at 20 ^{o}C.

It has been observed that return-flow drains to Boise River, particularly below Caldwell, deposit large quantities of silt and sludge on the stream bottom and contribute to the slimes and algal growths that have been noted at a number of locations in the river. Nutrient concentrations, total dissolved solids, silica and hardness of waters below Boise (Notus) are summarized in TABLE V-2. Increased stream temperatures associated also with irrigation return flows to lower Boise River have reached levels in excess of 70° F. According to fishery agencies, considerable damage to fish populations has occurred in this portion of the river.

TABLE VIII-1
PRESENT MUNICIPAL & INDUSTRIAL WASTE LOADS,[1/] BOISE BASIN, IDAHO

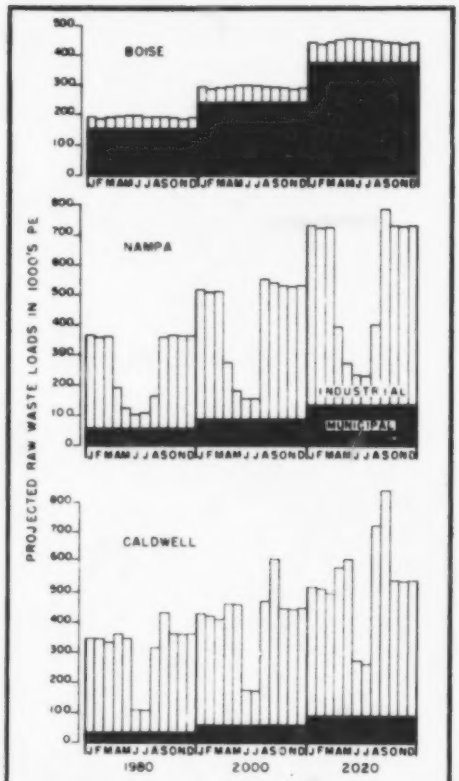
Area Classification	Population Equivalents (in thousands) Wastes Produced		Wastes Discharged	
BOISE				
Municipal		70		20
Industrial		38		11
Meat products	12		8	
Dairy products	26		3	
Total, Boise M&I		108		31
NAMPA				
Municipal		20		3
Industrial		371		18
Sugar refining	330		14	
Potato processing	20		2	
Meat products	21		2	
Canning & freezing*	(48)*		(5)*	
Total, Nampa M&I		391		21
CALDWELL				
Municipal		15		2
Industrial		281		117
Potato processing	260		100	
Meat products	16		16	
Dairy products	5		1	
Canning & freezing*	(100)*		(0)*	
Total, Caldwell M&I		295		119
TOTAL, BOISE BASIN		794		181

1/ These figures represent maximum waste production.
*Note: Canning and freezing industry waste loads are not included in totals because these wastes are produced during months of less than maximum waste production.

2. Future

a. Municipal and Industrial Wastes

Major M&I waste loading points on the Boise River occur at Boise, Nampa (Indian Creek), and Caldwell. The total quantity of waste expected to be generated at these locations by the years 1980, 2000, and 2020 during maximum production periods (September) is projected to be about 1,000,000 PE, 1,450,000 PE, and 2,000,000 PE, respectively. FIGURE 8 shows the monthly distribution an and relative proportion of projected M&I wastes expected to be generated at each major loading point along Boise River.


BOISE
NAMPA
INDUSTRIAL
CALDWELL
PROJECTED RAW WASTE LOADS IN 1000'S PE
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1980
2000
2020
FIGURE 8 - PROJECTED M & I RAW WASTE PRODUCTION

b. Agricultural Pollution

Agricultural wastes, irrigation return flows, and land runoff wastes are sources of BOD and other polluting constituents which are not readily conducive to evaluation or projection. In addition, it is shown in Chapter VI that the raising of domestic farm animals is expected to increase substantially in the study area. Waste loads from this source are taken into account in projecting future water quality of the river. Also, from studies in other areas--for example, the Yakima River Basin, where equally intensive irrigation is practiced--it has been shown that drainage water may attain BOD concentrations upwards of 3 mg/l and that nutrient concentrations can exceed by many fold the nutrient concentrations of stream waters into which those drainage waters are received. For purposes of this report, it is projected that future land and water management practices will tend to maintain agricultural waste water quality at a level similar to that existing at the present time.

C. WATER QUALITY CRITERIA

The quality of stream waters is described in terms of temperature, turbidity, chemical constituents, bacteriological quality, DO-BOD relationships, and other factors. The significance of several of these indicators of water quality was discussed in Chapter V.

Fishery agency proposals are to maintain somewhat higher levels of fishing intensity than presently exist in most reaches of the Boise River and to improve conditions for fish management below Caldwell. Objectives recommended in this report for quality control are aimed toward controlling organic waste pollution for maintenance of the fishery and recreational opportunities in the Boise-Caldwell reach, and improving the appearance and aesthetic quality of the river below Caldwell. Provisions for waste treatment and flow regulation to maintain a minimum DO level of 6 mg/l in the Boise reach, 4 mg/l in the Caldwell-Notus reach, and 3 mg/l at the mouth on a design frequency of nine out of ten years would provide benefits in terms of uses protected and values preserved in and along the Boise River. Recommendations for quality control regulation are, therefore, based on achieving these minimum average DO levels on the frequency stated above over the full projection period or to the year 2020.

The mineral quality of waters (TDS 500-600 mg/l) below Boise is satisfactory for irrigation and instream uses. As land management practices are expected to control mineral sources along the lower river, mineral quality criteria for flow regulation design is not involved.

D. FLOW REGULATION

Regulation necessary to achieve the above stated quality objective is based on stream flows required to dilute and assimilate present and projected organic waste loads from M&I sources (after treatment) and from agricultural sources. FIGURE 8 shows the waste loads used in the flow regulation computations.

Indicators of water quality such as bacteria, minerals, and turbidity are not conducive in this case to control by flow regulation. Waste disinfection, irrigation water saving, erosion control, and practices of this kind would provide control of these and other similar constituents. Flow regulation for the control of organic wastes would by dilution exert some improvement in these factors. Significant control of stream temperatures downstream from Lucky Peak Dam is not expected to occur as a result of releases at Twin Springs Reservoir. Additional flow over the streambed below diversions may exert some temperature reduction in the lower river.

The Federal Water Pollution Control Act, as amended (33 U.S.C. 466a(b)) provides that the inclusion of storage for regulation of stream flow water quality control shall not be provided as substitute for adequate treatment or other means of controlling waste at the source. Adequate treatment is considered by the Federal Water Pollution Control Administration to mean effective municipal waste collection and the application of the best available treatment methods considered economically feasible and equivalent reduction of industrial waste loads by a combination of process control, internal waste saving, water reuse, and effluent treatment. At the present time this is considered to be the application of secondary treatment by the trickling filter or activated sludge process. Efficiently operated trickling filter plants (widely used in intermediate-sized communities) are considered capable of 80 to 90 percent BOD removal. Considering the effect of diurnal fluctuations in waste loads, problems of efficient operation to maintain such high removals, experience with the lags in plant construction to provide for growth in waste loads, urban storm water, and/or combined sewer overflows, it is considered reasonable to expect the equivalent of 85 to 90 percent BOD removal in well-operated collection systems and treatment plants at this time.

In this study area, where the largest waste loads are from the food processing industry and where significant agricultural land wastes occur, it is believed that a BOD reduction of 85 percent with respect to the stream is feasible for estimating the future loadings to the river. Although higher treatment efficiencies may be attainable, this level, in addition to allowing for uncontrolled urban and rural land drainage, allows for unavoidable contingencies such as overloading, bypassing, or breakdown of treatment plant facilities. All of these considerations dictate a design efficiency of 85 percent BOD removal for flow regulation computation purposes.

The waste loadings to the Boise River consist primarily of wastes from potato, sugar, cannery, dairy and meat processing operations and from municipalities. Most of the wastes in the basin are produced at three points: the Boise, Nampa, and Caldwell areas. As may be seen in FIGURE 8, the waste loadings in the Boise area are primarily of municipal origin and remain relatively constant throughout the year. The waste loadings in the Nampa and Caldwell areas are primarily of industrial origin and fluctuate widely during the year depending upon the types of industry in operation at any specific time.

Stream flows required to maintain the objective under 1980, 2000, and 2020 conditions were computed by means of a technique for balancing the dissolved oxygen supply with dissolved oxygen demand in the stream. Computations were made by use of an "oxygen-sag" computer program which was designed to determine water quality control requirements in a complex river basin. (X-16)

Results of the analysis of the Boise River Basin indicated that the biochemical oxygen demand of the Boise area waste load would not be fully exerted between Boise and Caldwell. Thus, the partially assimilated Boise waste load would be superimposed on the Nampa-Caldwell waste loads entering the Boise River near Caldwell. These loads would then pass downstream from Caldwell to the mouth, again before complete BOD exertion. The minimum quality control flows required to assimilate the imposed waste loads were assumed to originate from storage above Boise and pass down the entire reach of river from Boise to the mouth of the river. A hypothetical profile of the lower river as it is presently regulated for irrigation is shown in FIGURE 9.

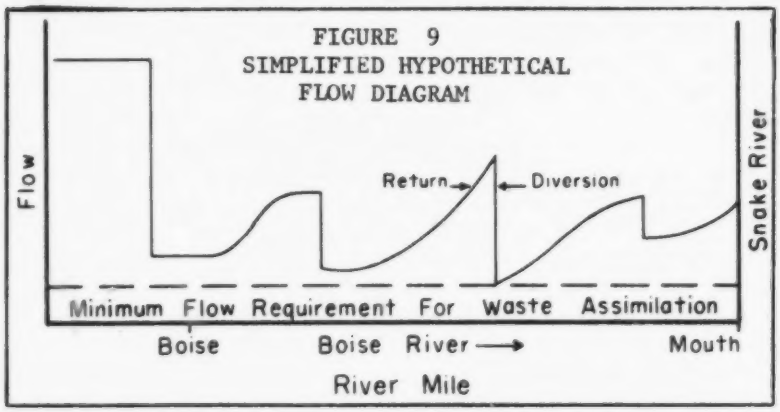


FIGURE 9
SIMPLIFIED HYPOTHETICAL
FLOW DIAGRAM

In computing minimum flow requirements for waste assimilation, it was recognized that drains carrying agricultural waste enter the river at a number of points below Boise. These wastes, for computation purposes, were taken into account in projecting the total residual waste loads expected to be received in the river.

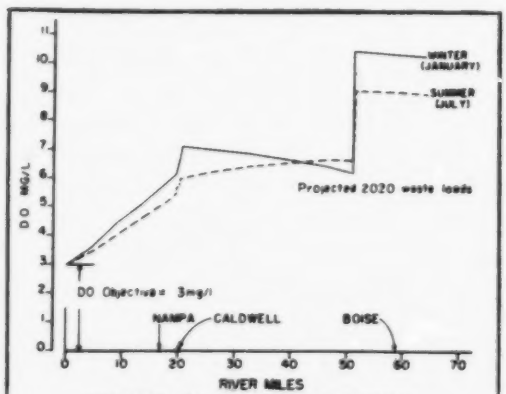


FIGURE 10 - HYPOTHETICAL
DISSOLVED OXYGEN PROFILE

Typical DO profiles were derived from the computer output data of the Boise River analysis as shown in FIGURE 10. It may be seen that the recommended DO objective of 5 mg/l at Caldwell results in levels of about 3 mg/l at the mouth. The drop in DO from about 9-10 mg/l above the Boise waste discharge point to about 6-7 mg/l immediately downstream is a result of high-volume, zero-DO wastes discharged to the stream.

Hydrographs of calculated flow requirements were superimposed on the critical one-in-ten year low-flow hydrograph (adjusted). Expected flow deficiencies were computed and converted to regulation storage requirements for the recommended DO objectives. These storage requirements are summarized below:

Design Year	Needed Draft on Storage (acre-feet)
1980	31,950
2000	60,450
2020	98,200

A typical example of how flows might be released from storage for quality control is shown in FIGURE 11. Under the assumed conditions of this example, it can be seen that critical flow conditions would exist at Boise during the months of October through February, while critical flow conditions would exist near Caldwell during the months of April through September. During the month of October, the flows released for quality control at Boise would be adequate near Caldwell. During September, the flow deficit near Caldwell would be greater than at Boise; thus, the flows released for quality control near Caldwell would be adequate at Boise. A summation of flow deficits, critical either at Boise or near Caldwell, and consequent conversion into storage requirements yields a total draft-on-storage need of 98,175 acre-feet for the assumed conditions of the example.

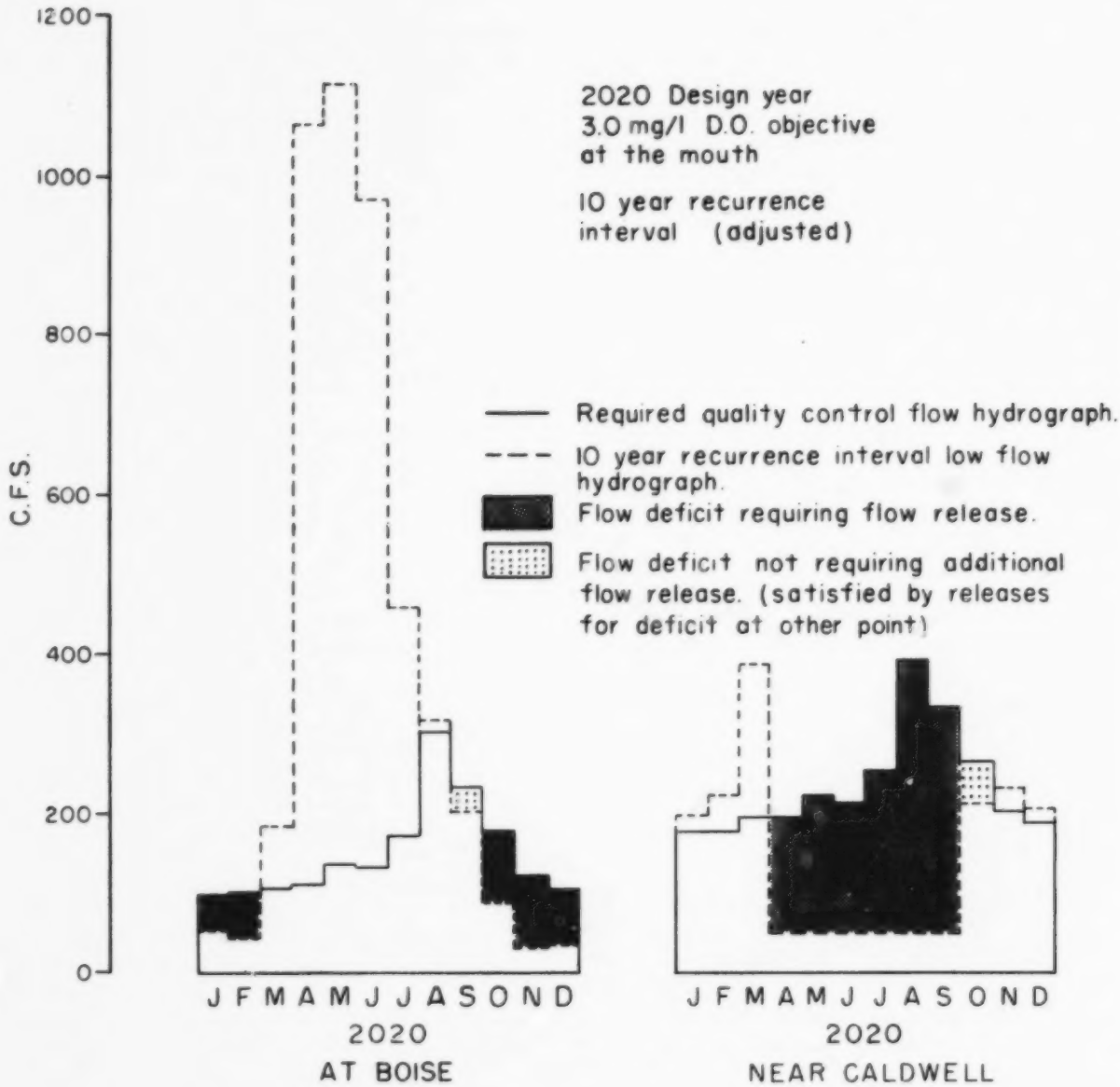


FIGURE 11 - TYPICAL QUALITY CONTROL RELEASE OPERATION

IX. BENEFITS

Benefits can be assigned to releases from storage for regulation of stream flow for water quality control only after adequate treatment or control of waste at the source is provided. In this instance, adequate waste control at the source or 85 percent BOD reduction with respect to the stream, would not by itself meet the quality goals discussed in Chapter VIII for the Boise and Caldwell-Notus reaches of the Boise River. Water quality goals can, however, be met by providing flow regulation in addition to adequate treatment.

Beneficiaries of flow regulation for water quality control are widespread throughout Boise River Basin. Benefits would arise through protection of fish and wildlife, maintenance of recreational opportunities, safeguards on public health, water quality for stock watering, and maintenance of attractive stream waters.

Maintenance of the Idaho Fish and Game Commission's sports fishery program is one of the more notable potential benefits to be derived from water quality control. Estimates of the fishing effort and stocking program of the State of Idaho are described in Chapter VIII, Section A-3.

Recreational opportunities throughout the 50 miles of river below the Boise metropolitan area would be directly benefited by controlled water quality, and a potential population of more than 550,000 persons would be expected to receive value from this control.

The uses to be served and values to be derived through maintenance of water quality in Boise River are not readily quantified in monetary terms. The minimum value of the benefit assignable to storage in the Twin Springs Project for water quality control is, however, considered at least equal to the cost of achieving the same level of water quality by alternative means in the absence of the proposed project.

Flow regulation by single-purpose means is the only alternative presently available to achieving results equivalent to those obtainable by releases from project storage. Waste disposal underground, waste transport downstream or to the Snake River, or waste holding for discharge during high flow would neither be advisable, feasible or produce similar results in view of the need to maintain sufficient stream flow wherein residual M&I waste and uncontrolled urban and rural runoff waste may be assimilated without damage.

For benefit computation purposes, single-purpose storage development costs at the Twin Springs site on the Middle Fork Boise River were selected. Based on capital and investment costs to develop and operate

this alternative, the minimum value of the benefit assignable to an annual draft-on-storage[1/] of 98,000 acre-feet in the proposed Twin Springs Project (assumed 100-year life at 3.125 percent interest), with first need beginning upon completion of the project (assumed completion in 1975), is $7.00 per acre-foot or $686,000.

In planning for additional water resource development in Boise River Basin, consideration should be given to preserving the excellent quality of water in upper basin regions and to maintaining sufficient quality in the lower river to permit reasonable use for fish life, recreation, and general aesthetic enjoyment. Maintenance of water quality for fish propagation would assure continued multiple use of the river and would necessitate continued updating of waste treatment facilities, improved land and water-management practices, and annual releases of water through the lower section of the river in the ultimate amount of 98,000 acre-feet. It is emphasized that, for benefits to be fully realized, a means must be devised whereby flows may be allowed to pass downstream during annual shutdown periods at Lucky Peak Dam.

Storage for quality control in Twin Springs Reservoir would provide protection of future water quality not only in the Boise River, but also in the Snake River. The adverse effect of organic wastes remaining after adequate treatment, as measured in terms of DO demand on the Boise River, can be reduced to acceptable levels with comparatively little additional regulation of the river. The wastes carried to the river in land drainage water, domestic septic tank drains, and other wastes which are not controllable by available means can be controlled by this regulation.

Controlled water quality will have an important impact on the area for which flow regulation would be provided. The Boise River flows through many communities and valuable farm lands and is a focal point to travelers passing through the valley. The beauty of the valley, its fisheries, recreation, and other water-oriented activities are an important asset to the region.

The beneficiaries of flow regulation for water quality control in the Boise River Basin are identifiable by general area, type and magnitude but because benefits cannot be solely identified with a given area or specific use, they are considered widespread in nature.

1/ Annual draft-on-storage is the sum of incremental excesses of needed releases over inflows during a climatic year (April through March)

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APPENDIX A

CENTRAL SNAKE RIVER SURVEY FIELD DATA[1/]
August - September 1965

Table 1 Boise River Station B-1 - Near Parma, Idaho

Table 2 Boise River Station B-5 - Near Notus, Idaho

Table 3 Boise River Station B-10 - Near Middleton, Idaho

Table 4 Boise River Station B-15 - Near Strawberry Glen, Idaho

Table 5 Boise River Station B-20 - Above Boise, Idaho

1/ Survey conducted by the U. S. Public Health Service.

APPENDIX A - CENTRAL SNAKE RIVER SURVEY FIELD DATA
August to September 1965

TABLE 1
BOISE RIVER STATION B-1
NEAR PARMA, IDAHO

DATE	TIME	RELATIVE STAGE	TEMP °C	pH	D.O. mg/l	% SATURATION
8/24/65	0935	15' 9"	18.7	8.12	7.15	83
8/24/65	1330	15' 9"	21.3	8.25	8.45	103
8/24/65	1735	15' 9"	23.0	8.28	9.35	118
8/24/65	2135	15'10"	20.2	8.18	7.20	87
8/25/65	0500	15' 9"	20.0	7.90	6.65	80
8/25/65	0520	15'10"	18.5	7.85	6.70	78
8/25/65	0915	15'10"	19.0	8.07	7.25	85
8/25/65	1325	16' 0"	19.5	8.07	8.70	103
8/25/65	1727	15'10"	21.0	8.17	8.95	109
8/25/65	2025	16' 2"	20.2	8.15	8.25	99
8/26/65	0250	15'10"	18.5	7.80	6.70	78
8/26/65	0515	16' 0"	17.5	7.80	6.70	76
8/26/65	0915	16' 0"	18.0	8.03	7.70	88
8/26/65	1330	16' 1"	20.0	8.25	9.80	117
8/26/65	1710	15'11"	22.0	8.28	10.00	124
8/26/65	2015	15'11"	21.3	8.20	8.40	103
8/27/65	0245	15'10"	19.0	7.82	6.90	81
8/27/65	0650	16' 1"	17.5	7.85	7.05	80
8/27/65	0935	16' 0"	18.0	8.12	7.85	90
8/27/65	1345	16' 1"	20.7	8.15	9.95	120
8/27/65	1730	16' 0"	22.0	8.37	9.30	115
8/27/65	2000	16' 1"	21.5	8.12	7.30	89
8/28/65	0235	15'11"	18.5	7.96	6.30	73
8/28/65	0510	15'11"	17.5	7.85	5.30	60
8/28/65	0910	16' 0"	16.5	7.98	7.30	81
8/28/65	1350	16' 3"	19.0	8.32	10.40	122
8/28/65	1710	16' 1"	20.0	8.43	10.45	125
8/28/65	2000	16' 1"	18.6	8.32	9.40	110
8/29/65	0225	16' 1"	16.8	7.95	7.75	87
8/29/65	0517	16' 4"	15.5	7.83	6.60	72

SOURCE: U. S. Public Health Service

TABLE 2
BOISE RIVER STATION B-5
NEAR NOTUS, IDAHO

DATE	TIME	RELATIVE STAGE	TEMP °C	pH	D.O. mg/l	% SATURATION
8/24/65	0915	12'11"	18.1	7.92	7.20	83
8/24/65	1315	12'10"	21.0	8.20	9.20	112
8/24/65	1718	12'10"	22.0	8.05	7.35	91
8/24/65	2110	12'10"	21.6	7.80	5.75	71
8/25/65	0440	12'10"	19.5	7.80	6.85	81
8/25/65	0508	21'11"	18.5	7.80	6.95	81
8/25/65	0900	12'11"	18.0	7.90	7.55	87
8/25/65	1310	12'11"	20.0	8.10	8.35	100
8/25/65	1710	12'11"	20.0	7.98	7.95	95
8/25/65	2005	12'11"	20.0	7.95	7.05	84
8/26/65	0225	13' 0"	18.2	7.75	6.35	73
8/26/65	0500	13' 0"	16.5	7.85	7.10	79
8/26/65	0855	13' 1"	18.0	7.98	8.00	92
8/26/65	1315	13' 0"	20.0	8.12	9.35	112
8/26/65	1650	13' 0"	21.0	8.17	8.40	102
8/26/65	1955	13' 0"	20.5	7.98	7.10	86
8/27/65	0230	13' 3"	18.6	7.72	7.00	81
8/27/65	0635	13' 1"	17.0	7.95	7.15	80
8/27/65	0920	12' 1"	18.0	8.07	8.15	94
8/27/65	1330	13' 0"	20.7	7.95	7.80	94
8/27/65	1710	13' 1"	21.5	8.18	7.70	94
8/27/65	1940	13' 3"	20.8	8.05	7.70	93
8/28/65	0220	13' 0"	18.7	7.74	5.50	64
8/28/65	0455	13' 1"	17.5	7.84	5.60	63
8/28/65	0850	13' 2"	16.5	7.92	7.70	86
8/28/65	1335	13' 1"	18.5	8.23	10.10	112
8/28/65	1655	13' 2"	20.0	8.28	9.90	118
8/28/65	1945	13' 2"	18.6	8.15	8.80	102
8/29/65	0205	13' 3"	17.0	7.73	6.20	70
8/29/65	0502	13' 2"	15.0	7.75	6.85	74

SOURCE: U. S. Public Health Service

TABLE 3
BOISE RIVER STATION B-10
NEAR MIDDLETON, IDAHO

DATE	TIME	RELATIVE STAGE	TEMP °C	pH	D.O. mg/l	% SATURATION
8/24/65	0850	12' 8"	17.5	7.75	7.85	89
8/24/65	1255	12' 7"	20.5	8.20	9.75	117
8/24/65	1655	12' 8"	23.0	8.30	9.85	124
8/24/65	2040	12' 8"	21.4	8.00	7.80	95
8/25/65	0420	13' 0"	19.0	7.70	7.05	82
8/25/65	0450	12' 8"	18.0	7.65	7.10	81
8/25/65	0835	12' 9"	18.0	7.75	7.75	89
8/25/65	1250	12' 9"	20.5	8.17	9.80	118
8/25/65	1650	12' 8"	21.0	7.75	9.70	118
8/25/65	1945	12' 8"	20.0	7.82	8.90	106
8/26/65	0215	12'10"	17.0	7.45	7.70	87
8/26/65	0443	12'10"	16.5	7.56	7.55	84
8/26/65	0835	12'10"	17.0	7.82	8.35	94
8/26/65	1255	12'10"	20.0	8.10	9.85	118
8/26/65	1635	12'10"	22.0	8.10	10.40	129
8/26/65	1935	12'10"	21.3	8.15	8.80	107
8/27/65	0205	12'10"	-	7.45	7.15	85
8/27/65	0620	12'10"	16.5	7.75	7.25	81
8/27/65	0900	12'10"	17.0	7.83	8.30	93
8/27/65	1310	12' 9"	20.5	7.85	10.05	121
8/27/65	1645	12' 9"	22.0	8.28	9.95	122
8/27/65	1920	13' 2"	21.4	8.14	8.85	108
8/28/65	0205	12'10"	18.5	7.60	7.15	83
8/28/65	0440	12'10"	17.0	7.70	7.10	80
8/28/65	0835	12'10"	16.5	7.62	8.15	91
8/28/65	1315	12'10"	18.5	8.23	10.40	120
8/28/65	1635	12'10"	20.0	8.30	10.45	125
8/28/65	1925	12'10"	19.0	8.20	9.40	110
8/29/65	0150	13' 1"	16.1	7.62	7.95	87
8/29/65	0445	12' 9"	14.5	7.45	7.80	83

SOURCE: U. S. Public Health Service

APPENDIX A - CENTRAL SNAKE RIVER SURVEY FIELD DATA
August to September 1965

TABLE 4
BOISE RIVER STATION B-15
NEAR STRAWBERRY GLEN, IDAHO

DATE	TIME	RELATIVE STAGE	TEMP °C	pH	D.O. mg/l	% SATURATION
8/24/65	0820	14' 2"	15.0	7.60	8.75	95
8/24/65	1230	14' 1"	17.2	7.82	9.30	105
8/24/65	1630	14' 2"	21.0	7.82	9.10	110
8/24/65	2000	14' 2"	20.0	7.48	7.75	93
8/25/65	0350	14' 2"	16.0	7.40	8.40	92
8/25/65	0425	14' 3"	15.0	7.35	8.20	88
8/25/65	0815	14' 2"	16.0	7.42	8.90	98
8/25/65	1225	14' 5"	18.0	7.52	9.45	108
8/25/65	1625	14' 2"	19.0	7.55	9.45	110
8/25/65	1915	14' 5"	18.8	9.05	8.60	100
8/26/65	0150	14' 2"	15.8	7.45	8.35	91
8/26/65	0420	14' 6"	14.5	7.45	8.25	88
8/26/65	0815	14' 3"	15.0	7.45	8.90	96
8/26/65	1230	14' 6"	18.0	7.70	9.60	110
8/26/65	1610	14' 2"	20.0	7.42	9.00	107
8/26/65	1910	14' 4"	20.0	7.45	8.20	98
8/27/65	0140	14' 8"	16.0	7.30	8.20	90
8/27/65	0600	14' 7"	14.5	7.48	8.40	89
8/27/65	0835	14' 2"	15.0	7.65	9.15	98
8/27/65	1240	14' 6"	18.0	7.45	9.50	109
8/27/65	1620	14' 3"	20.0	7.72	9.15	109
8/27/65	1855	14'10"	19.6	7.53	8.40	100
8/28/65	0135	14' 4"	16.4	7.32	7.90	88
8/28/65	0420	14' 7"	15.0	7.33	8.20	88
8/28/65	0810	14' 4"	15.0	7.30	8.90	95
8/28/65	1250	14' 8"	17.0	7.67	9.75	109
8/28/65	1610	14' 3"	18.0	7.67	9.45	108
8/28/65	1900	14' 2"	17.6	7.47	8.90	102
8/29/65	0125	14' 3"	14.6	7.21	8.65	92
8/29/65	0420	14' 6"	13.0	7.12	8.70	90

SOURCE: U. S. Public Health Service

APPENDIX A - CENTRAL SNAKE RIVER SURVEY FIELD DATA
AUGUST to SEPTEMBER 1965

TABLE 5
BOISE RIVER STATION B-20
ABOVE BOISE, IDAHO (3 Miles)

DATE	TIME	RELATIVE STAGE	TEMP °C	pH	D.O. mg/l	% SATURATION
8/24/65	0745	18' 8"	15.0	8.50	9.15	98
8/24/65	1200	18' 7"	17.5	7.70	9.05	103
8/24/65	1600	18' 8"	18.0	7.60	8.95	103
8/24/65	1926	18'10"	16.8	7.40	9.05	101
8/25/65	0325	18' 6"	15.5	7.50	9.40	102
8/25/65	0405	18' 7"	14.5	7.40	9.30	99
8/25/65	0745	18' 7"	15.0	7.42	9.20	100
8/25/65	1200	18' 8"	18.0	7.47	9.30	107
8/25/65	1600	18' 8"	17.0	7.50	9.05	102
8/25/65	1805	18' 1"	16.4	7.50	9.45	105
8/26/65	0125	18' 8"	14.8	7.26	9.40	100
8/26/65	0400	18' 9"	14.5	7.64	9.35	99
8/26/65	0745	18' 8"	15.0	7.30	9.30	100
8/26/65	1205	18' 8"	18.0	7.55	9.20	105
8/26/65	1535	18' 8"	18.0	7.33	9.05	104
8/26/65	1840	18' 8"	16.8	7.28	9.10	102
8/27/65	0115	18' 8"	15.0	6.95	9.55	102
8/27/65	0535	18' 7"	14.5	7.40	9.40	100
8/27/65	0805	18' 8"	15.0	7.65	9.10	98
8/27/65	1215	18' 8"	17.0	7.35	9.20	103
8/27/65	1550	18' 8"	18.0	7.53	8.90	102
8/27/65	1830	18'10"	17.0	7.40	9.10	102
8/28/65	0105	18' 8"	15.0	7.32	9.40	101
8/28/65	0357	18'10"	14.5	7.10	9.20	98
8/28/65	0745	18' 9"	15.0	7.56	9.40	101
8/28/65	1220	18' 9"	16.0	7.28	9.30	102
8/28/65	1540	18' 9"	16.5	7.60	9.30	103
8/28/65	1830	18'10"	15.8	7.33	9.35	102
8/29/65	0100	18' 9"	14.3	6.87	9.65	102
8/29/65	0355	18' 9"	13.5	7.11	9.60	100

SOURCE: U. S. Public Health Service

APPENDIX B

WATER QUALITY DATA

Table 1 Chemical Analyses of Wells, Boise, Idaho

Table 2 Chemical Analyses of Existing Water Supplies Caldwell, Idaho

Table 3 Chemical Analyses of Wells Nampa, Idaho

Table 4 Typical Water Quality Boise River, Idaho

Table 5 Bacteriological Data Boise River Basin, Idaho

APPENDIX B

TABLE 1

CHEMICAL ANALYSES, BOISE, IDAHO WELLS
Concentrations Expressed in Parts Per Million

Date of Analysis	Source of Sample (Wells)	pH	Total Dissolved Solids	Alkalinity as $CaCO_3$ CO_3	Alkalinity as $CaCO_3$ HCO_3	Total Hardness as $CaCO_3$	Ca	Mg	Fe	Mn	NH_3	F	Cl	SO_4	NO_3 as N	PO_4	Na	N
2-24-61	Arctic	8.0	210	0	144	100	35.2	3.2	.02	.09		.48	7	24	.02	.05	33	
6-23-61	West Moreland	8.0	110	0	58	50	20	0	.11	.05		.42	3	2.4	.06	.20	14	
6-23-61	Westland Acres	7.4	260	0	110	115	40	3.6	.33	.34		.44	10	29	.04	.27	22	
7- 5-61	Roosevelt #1	7.5	440	0	264	180	52.8	12	.04	.32		.86	17	70.8	.05	.22	89	
7- 5-61	Roosevelt #2	8.6	160	10	80	42	15	1	.01	.00	.39	.62	8	9	.05	.04	32	
7- 5-61	Country Club	8.3	200	0	82	72	26	1.7	.02	.02		.66	10	26	.05	.14	26	
5-18-61	Taggart	7.8	140	0	74	60	18.4	4	.04	.00	.12	.64	4	9.6	.00	.00	23	
5-18-61	Cliffside	7.2	190	0	148	138	44	7.6	.15	.14	.21	.55	10	44	1.5	.04	36	.21
5-18-61	Chamberlin #1	7.7	125	0	68	58	18.4	3.2	.11	.00	.21	.66	5	11.4	.00	.04	18	.21
2-24-61	Chamberlin #2	7.1	260	0	168	148	42	11	.19	.00		.40	10	34.8	1.6	.16	28	
6-23-61	16th Street	7.8	215	0	105	110	36	4.8	.22	.08		.46	8	26	.03	.08	18	
6-23-61	13th & Front	8.0	160	0	70	70	24	2.4	.44	.05		.37	7	21	.05	.09	16	
7- 5-61	Orchid	7.1	260	0	108	86	41	1	.15	.18		1.70	10	63	.05	.04	38	
7- 5-61	Mountain View	7.4	225	0	86	88	32	1	.13	.09	.24	2.4	7	40.8	.05	.03	34	
7- 5-61	Long Meadow	6.6	120	0	56	72	22.4	4	.04	.00		.35	10	11.4	.10	.05	9	
5-18-61	Collectors	7.0	85	0	44	50	16	3.2	.10	.00	.24	.35	4	5.4	.15	.00	7	
5-18-61	Artesian (Highlands)	7.4	320	0	130	194	75	1.5	.12	.34		.40	8	91.2	.10	.07	24	

SOURCE: Idaho State Department of Health.

TABLE 2

CHEMICAL ANALYSES OF EXISTING WATER SUPPLIES,

CALDWELL, IDAHO

Source	Total Dissolved Solids ppm	Alkalinity as $CaCO_3$ CO_3 ppm	Alkalinity as $CaCO_3$ HCO_3 ppm	Total Hardness as $CaCO_3$ ppm	Ca ppm	Mg ppm	Fe ppm	F ppm	ppm	SO_4 ppm	Temp. °F.
Pump Station No. 1 - Rose Garden	118	0	62	34	10	2	0.07	0.35	4	5.4	64
Pump Station No. 2 - South Park	191	0	116	60	19	3	0.07	0.65	9	9.5	64
Pump Station No. 3 - College	204	0	124	54	19	1.5	0.05	0.70	11	7.7	--
Pump Station No. 5 - City Hall	180	0	104	40	14	1	--	0.70	9	10.4	--

Note: Data from Idaho State Department of Public Health records, based upon samples obtained in June, 1952.

TABLE 3

CHEMICAL ANALYSES,
NAMPA, IDAHO WELLS

Well No.	1 and 2	3	4	5	6	PHS Recomm. Max.
Iron	0.06	0.06	0.06	0.06	0.06	0.3
Calcium	16	10	15	18	14	
Magnesium	2	0	1.5	2	4	
Sodium	45	44	43	44	12	
HCO_3 Alkalinity	116	108	120	114	102	
Sulfate	14	8	7	11	10	250
Chloride	12	6	8	7	8	
Fluoride	1.45	1.4	1.4	1.3	1.1	1.5
Total Dissolved Solids	104	188	184	200	174	500
Hardness	38	36	44	50	52	
pH	7.6	7.6	7.6	7.6	7.4	

Data from Idaho State Department of Health records, based upon samples obtained 12/11/59.

APPENDIX B

TABLE 4
TYPICAL WATER QUALITY, BOISE RIVER, IDAHO

Location & Date	Temp. °F (*°C)	pH	Percent Sat.	MPN per 100 ml	Milligrams per Liter (mg/l) DO	BOD_5	TDS	Hardness	Nitrates	Phosphates
ABOVE BOISE										
8/11-13/59	61	6.8	91	--	9.1	1.2	46	32	0.15	0.07
1/17/63	32	7.1	91	--	12.9	2.3	80	40	0.10	0.02
2/4-19/63	7.7*	7.8	--	1,300	11.0	1.2	--	49	1.63	--
8/24/65	17.5*	7.7	103	<10	9.1	1.5	106	--	0.05	<0.01[b]
8/28/65	16 *	7.3	102	1,000	9.3	0.6	34	--	0.04	0.02[b]
BROADWAY BRIDGE										
1/12-14/60	34	---	89	460	12.7	2.1	130	52	0.5	0.09
1/12/61	37	7.0	92	1,100	12.5	3.6	192	--	0.2	--
2/20/62	42	7.3	107	6,500[a]	13.6	---	--	62	0.3	0.13
AT STRAWBERRY GLEN										
8/11-13/59	66	7.2	103	---	9.7	2.7	70	34	0.45	0.07
1/12-14/60	41	7.2	98	11,000	12.6	26.0	248	94	2.9	2.5
1/12/61	47	7.2	90	24,000	10.6	18.0	292	--	---	---
2/20/62	42	7.2	79	10,300	10.0	---	---	94	0.75	2.5
1/17/63	39	7.0	94	---	11.9	11.3	140	70	3.1	1.64
2/4-19/63	7.5*	7.6	--	1,700	9.8	7.0	---	89	1.63	---
8/24/65	17.2*	7.8	105	1,100	9.3	1.8	86	--	0.06	0.37[b]
8/28/65	17.0*	7.7	109	1,500	9.8	1.1	50	--	0.07	0.30[b]
AT NOTUS										
8/11-13/59	71	7.3	108	3,300[a]	9.6	2.9	572	142	0.45	0.36
1/12-14/60	43	7.5	42	460,000	5.2	31.0	558	186	1.3	0.93
1/12/61	43	7.2	73	150,000	9.1	10.5	534	210	1.2	0.99
2/20/62	47	7.5	48	63,100[a]	6.6	---	520	178	1.25	0.76
8/24/65	21.6*	7.8	71	---	5.75	---	---	---	---	---

(continued, next page)

APPENDIX B

TABLE 4 (Continued)

TYPICAL WATER QUALITY, BOISE RIVER, IDAHO

Location & Date	Temp. °F (°C*)	pH	Percent Sat.	MPN per 100 ml	Milligrams per Liter (mg/l) DO	BOD_5	TDS	Hardness	Nitrates	Phosphates
NEAR PARMA										
8/24/61	21*	7.8	---	---	7.3	2.7	626	232	1.14	0.56
1/15/62	4*	7.7	---	24,000	9.9	8.6	551	216	0.50	0.55
1/17/63	39	7.1	71	---	9.0	9.0	390	192	0.10	0.59
2/20/63	48	7.5	---	---	7.9	2.3	---	211	---	---
1/16/64	2*	7.1	---	---	9.9	6.5	---	---	2.44	0.53 b/
8/24/65	21.3*	8.3	103	8,800	8.4	2.5	332	---	0.34	0.24 b/
8/28/65	19*	8.3	122	2,700	10.4	1.75	301	---	0.49	0.48 b/
12/9/65	6*	8.3	---	92,000	8.3	7.8	453	---	0.89	0.61

* Degrees Centigrade (°C).

a/ Membrane Filter.
b/ Ortho Phosphate.

TABLE 5
BACTERIOLOGICAL DATA
BOISE RIVER BASIN, IDAHO

River Mile	Date	MPN/100 ml
58.2	8/24-25/65	<10 *
	8/25-26/65	<10 *
	8/26-27/65	70 *
	8/27-28/65	2,100 *
	8/28-29/65	1,000 *
47.1	8/24-25/65	1,100 *
	8/25-26/65	200 *
	8/26-27/65	5,900 *
	8/27-28/65	2,300 *
	8/28-29/65	1,500 *
5.0	8/24-25/65	8,800 *
	8/25-26/65	1,200 *
	8/26-27/65	4,100 *
	8/27-28/65	4,400 *
	8/28-29/65	2,700 *
53	11/29/51	2,400
39	11/29/51	1,300
25.7	12/4/51	24,000
13.8	12/4/51	≥240,000
5.0	12/4/51	≥240,000
53.7	1/12-14/60	460
50.6	1/12-14/60	46,000
47.1	1/12-14/60	11,000
42.3	1/12-14/60	<11,000
25.7	1/12-14/60	< 1,100
21.8	1/12-14/60	>11,000
21.0	1/12-14/60	>110,000
19.6	1/12-14/60	240,000
13.8	1/12-14/60	460,000
58.2	2/12/63	7,900
47.1	2/12/63	1,700
25.7	2/12/63	1,300
13.8	2/12/63	79,000
5.0	2/12/63	130,000

* Membrane Filter.
SOURCE: Public Health Service & Idaho State Dept. of Health.

APPENDIX C

LETTER FROM THE CITY OF BOISE

CITY OF BOISE
IDAHO

COUNCILMEN
HENRY F. KOCH, PRESIDENT
EDWARD W. RICE, PRESIDENT PRO-TEM
SHERMAN A. PERRY
RALPH F. FRAZER
ANNA HETTINGER
WILLIAM ONWEILER

JAY S. AMYX
MAYOR

MAYOR
DEPARTMENT

August 16, 1966

Mr. James L. Agee
Deputy Director
Columbia River Basin Project
570 Pittock Block
Portland, Oregon

Gentlemen:

Boise City has undertaken a study of long range water supply needs of Boise City and adjacent vicinity, including the present and future requirements, which study shall include potential sources of supply and shall necessarily include an assessment of the current water rights of citizens for irrigation in the vicinity of Boise City. A resolution creating a committee for this purpose will be introduced before the Council meeting at its regular meeting to be held August 22, 1966, a copy of said resolution being forwarded herewith.

Boise City cannot and is not prepared at this time to define the ultimate storage requirements of this vicinity. Necessarily this will have to be determined by a study through the committee appointed.

Present examination of the existing source of supply for Boise City, together with the estimate of increase in population, creates a grave doubt as to the ability of the present supply to meet the long range

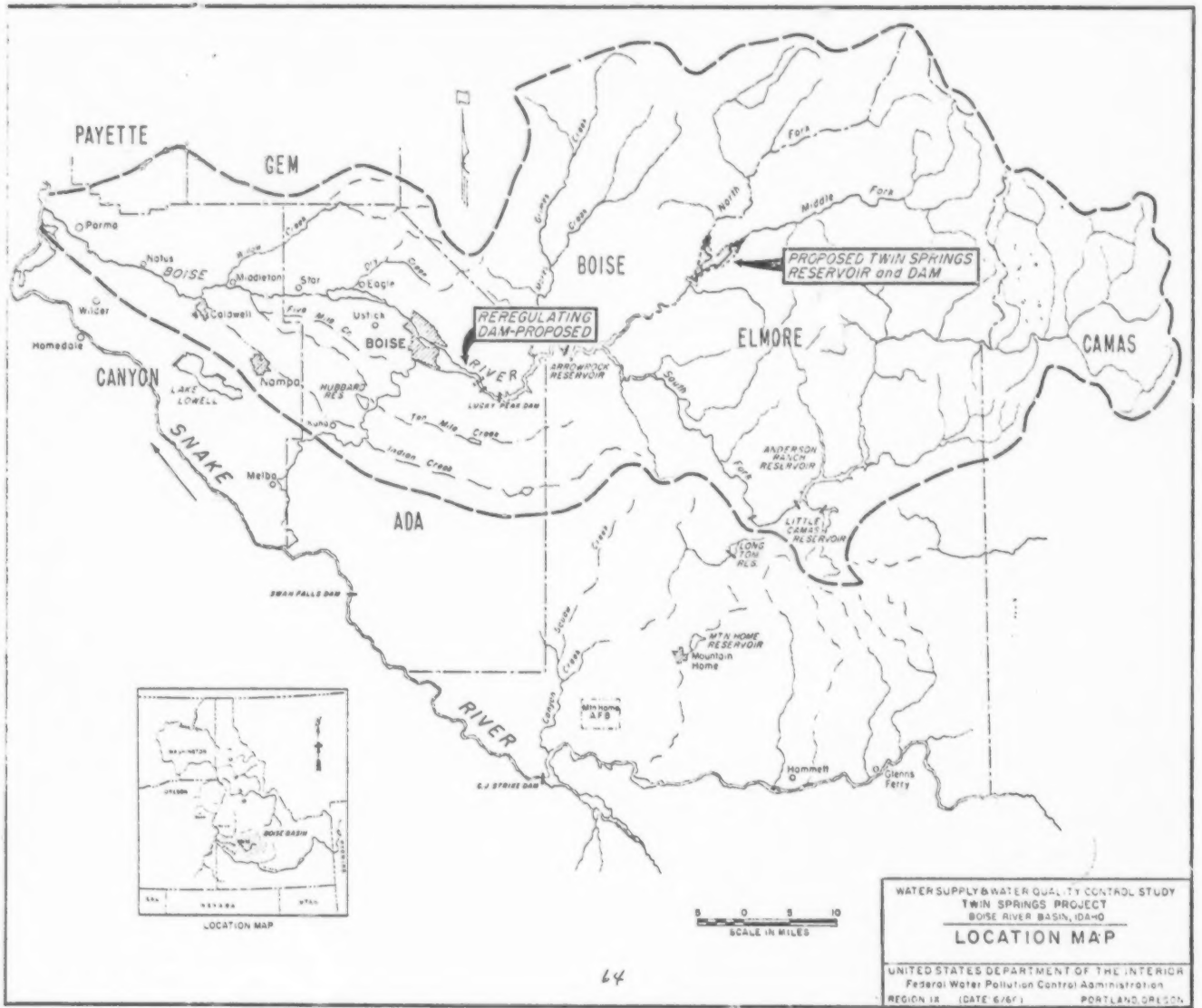
needs of the community of Boise.

Boise City is aware of the proposed development of water supply, for domestic, municipal, industrial and other purposes, through the Twin Springs project and desires to be considered as potential participant in such project for the development of water for domestic and municipal purposes.

It is understood that such participation by Boise City would be under 43 U.S.C. 390b (Title III, P. L. 85-500, as amended by P. L. 87-88).

Very truly yours,

Jay S. Amyx
Mayor



WATER SUPPLY & WATER QUALITY CONTROL STUDY
TWIN SPRINGS PROJECT
BOISE RIVER BASIN, IDAHO

LOCATION MAP

UNITED STATES DEPARTMENT OF THE INTERIOR
Federal Water Pollution Control Administration
REGION IX (DATE: 6/67) PORTLAND, OREGON

Figure 5